COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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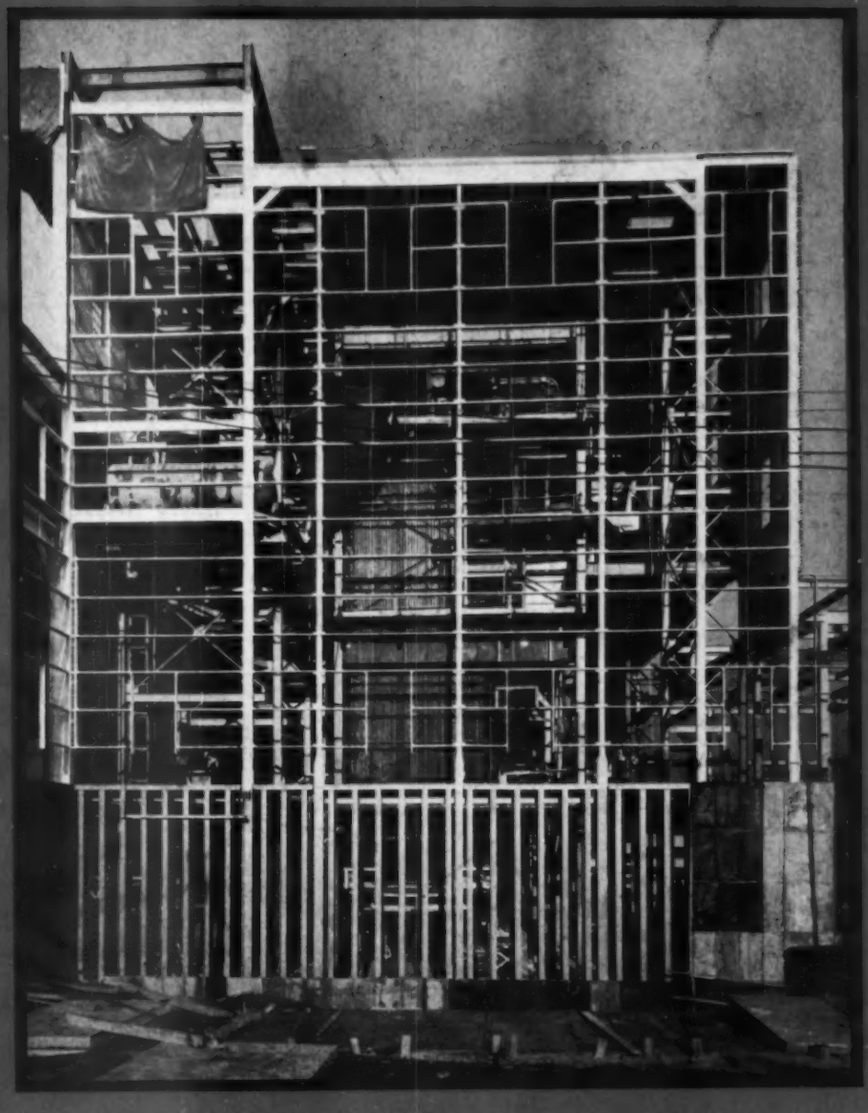
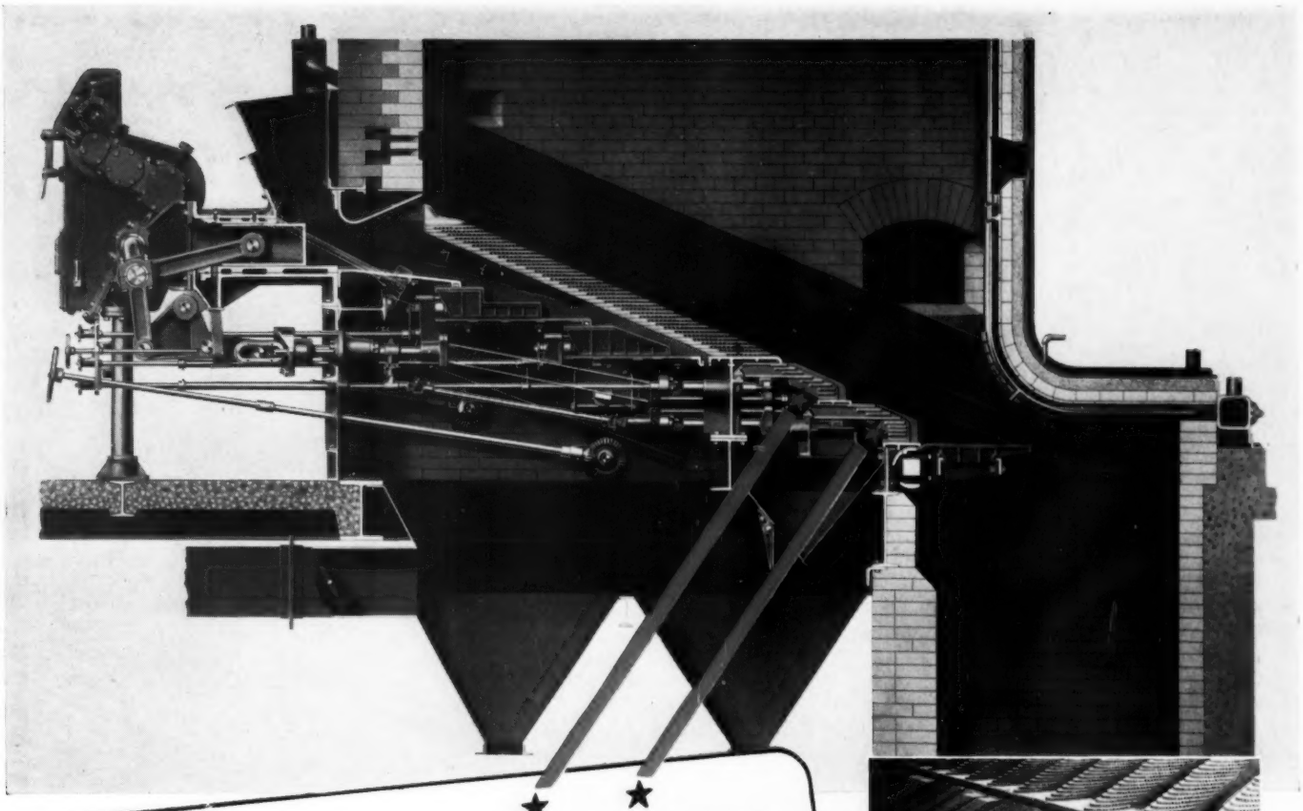


Construction view of a new utility plant in which building was erected around equipment

Power Plants of the LIBERTY SHIPS ▶

Dust Problems in Burning Blast-Furnace Gas Under Steam Boilers ▶



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COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME THIRTEEN NUMBER ELEVEN

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H. STUART ACHESON, *Advertising Manager* | ALFRED D. BLAKE, *Editor* | THOMAS E. HANLEY, *Circulation Manager*

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Avenue, New York

A SUBSIDIARY OF COMBUSTION ENGINEERING COMPANY, INC.

Frederic A. Schaff, President; Charles McDonough, Vice-President; H. H. Berry, Secretary and Treasurer.

COMBUSTION is sent gratis to engineers in charge of steam plants from 500 rated boiler horsepower up and to consulting and designing engineers in this field. To others the subscription rate, including postage, is $2 in the United States, $2.50 in Canada and Great Britain and $3 in other countries. Single copies: 25 cents.

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Issued the middle of the month of publication.

Publication office, 200 Madison Ave., New York CCA Member of the Controlled Circulation Audit, Inc.

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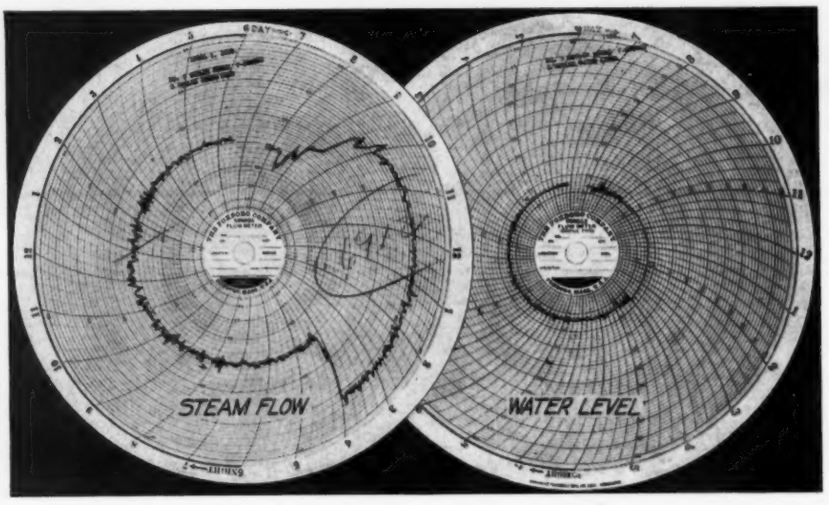

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EDITORIAL

Functions of Power Agencies Defined

For some time it has been apparent that overlapping of authority, duplication of effort and uncertainties prevailed as to the relative functions of the Power Branch of the War Production Board and the Federal Power Commission in the handling of power problems incident to the war effort. This was inevitable inasmuch as the FPC early undertook the planning of power supply and the Power Branch of WPB was created later primarily to cope with the materials and equipment situation and other special problems as they arose. Moreover, it is but natural for governmental agencies to extend their authority where it is not clearly defined. This appears to have resulted in confusion not only within these bodies but perhaps to a greater extent in the minds of those who have had to deal with them. It is, therefore, a welcome announcement that an agreement has been reached, with Presidential approval, which clearly defines the functions of these two groups.

Under this agreement the FPC will continue, as heretofore, to survey and license hydro projects; to collect data as to electric generation, its transmission and distribution; to supervise accounting and rates for electricity and gas in interstate commerce; to pass upon the disposition, acquisition and merger of utility properties; and to supervise plant protection against sabotage.

The Power Branch of WPB is charged with the responsibility for assuring that materials and equipment for power supply are made available where most needed; for determining the demands and supply of power to meet the war production program; for planning and administering allocations of power to those regions where present facilities are inadequate; and for the mobilization of power and coordination of transmission to meet specific war production requirements.

This clarification of the respective functions should make for smoother and speedier handling of defense power problems.

Technical Man Power

The recent registration of men from forty-five to sixty-four has produced some speculation as to how it may affect engineers within this non-combatant age group, especially those whose present duties are not directly related to the war effort.

Intended primarily as the prelude to a survey of skilled and non-skilled workers through the medium of questionnaires to be mailed later to all registrants, the information will be used by the recently created commission, under the direction of Paul V. McNutt, to mobilize the nation's man power for meeting the prospective needs of the war program. It will require some months to collect and correlate this information and details as to how it will be utilized have not yet been announced; nor has there been any intimation concerning its application to professional groups.

Although not to be taken as a criterion of what may ultimately develop here, the reported action of the Canadian Government with respect to technical men may be of interest. There, any practicing engineers or those engaged in design, construction, manufacturing, operation or maintenance may be called upon by the Wartime Bureau of Technical Personnel to undertake essential war work upon thirty days' notice. Employers must release such men unless a valid reason for not doing so can be offered and is accepted. Reinstatement at the conclusion of the emergency is mandatory. This rule also applies to engineers occupying executive positions, to chemists, research men and those engaged in teaching, and to any others possessing technical qualifications deemed useful to the government.

While the supply of technical men in the United States is infinitely greater than that in Canada, the number of war industries is correspondingly greater. On the other hand, as the stoppage or conversion of non-essential production to war work progresses, more and more engineers will become available for war work.

It is too early to predict how the latest registration in this country may ultimately affect engineers, but as the plans of the War Man Power Commission crystallize, they undoubtedly will also apply to technical men as well as to labor.

Meeting Accelerated Production

Many industrial power plants are today being called upon for sustained operation at capacities in excess of normal, without opportunity to carry out the customary scheduled outages for inspection, cleaning and maintenance. The seven-day week which now prevails in numerous war production plants and the necessity for utilizing reserve capacity to meet additional loads, have tended to lengthen the periods between these outages, despite the fact that such operation makes desirable more frequent inspection and cleaning. Thus a heavy responsibility rests on the operators, as any loss in available power capacity may mean curtailment in vital production. They cannot afford to take chances, yet have to meet imposed conditions that are not in line with best operating practice.

This situation calls for special care in operation to detect any signs of impending trouble and to plan corrective measures in advance. Feedwater conditioning must receive close attention and every piece of essential equipment should be studied in order to become familiar with its characteristics and limitations. Operating instruction books will bear re-reading and where it becomes necessary to depart from recommended procedures, the equipment manufacturer should be consulted.

Power Plants of the LIBERTY SHIPS

In view of the wide publicity that has been given the Liberty Ships, it was believed that many COMBUSTION readers would be interested in learning something about the standardized type of power plant employed to drive these vessels. Without going into details of design, the following gives the high-spots of this equipment which has been selected with a view to speed in output, minimum interference with other war production and simplicity in operation.

WITH the war spread to practically all corners of the earth, with our most active combat zones thousands of miles from the sources of supply, with the necessity of supplying vast quantities of war materials to our allies and bringing in certain strategic raw materials, and faced with an intensive submarine menace along our coasts, shipping facilities have become a paramount factor in successfully prosecuting the war. Fortunately, our government foresaw this situation and many months ago embarked upon a vast program of cargo ship construction under the direction of the Maritime Commission which had previously been created to carry out a long-range program involving vessels of the C1, C2 and C3 classes.[1]

[1] See "High Pressures and Temperatures Planned for Marine Field," by J. E. Schmeltzer, U. S. Maritime Commission, COMBUSTION, April 1940.

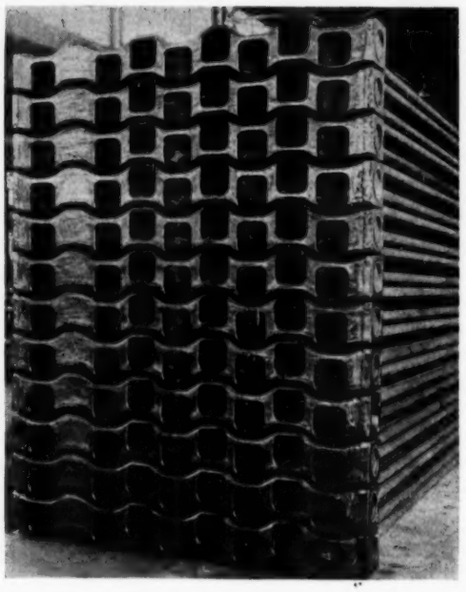


Fig. 2—Group of headers stacked on their sides on shop floor

The emergency program, comprising some 2300 vessels of all types to be completed within a two-year period, centers around the so-called "Liberty Ships," a standardized type of cargo vessel of approximately 14,000 tons displacement for which contracts for 1500 have already been let. It is expected that half this number will be in

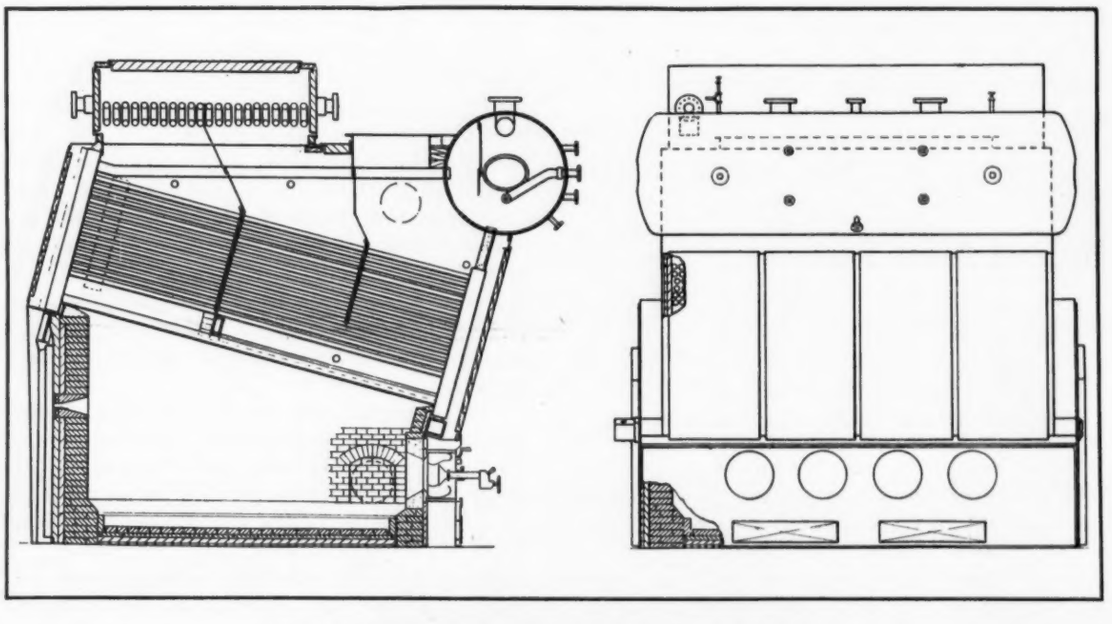


Fig. 1—Section and elevation of standardized boiler

service this year and the remainder in 1943. In fact, a considerable number have already been delivered and are doing their part toward defeating the Axis.

The idea underlying the design of these Liberty ships was mass production and their construction in numerous yards that were not engaged in other work. Similarly, in designing the power plants of these vessels, simplicity, standardization and ability to use manufacturing facilities not conflicting with urgent naval and stationary power demands were kept in mind. To this end the type and design of boiler selected were such as could be produced by a number of boiler companies, and by employing reciprocating engines for the main and auxiliary drives no burden was placed on the already overloaded turbine manufacturing facilities. While the building of reciprocating engines has decreased greatly during the last fifteen years, there were still many shops throughout the country with equipment and the necessary experience for turning out this type of prime mover.

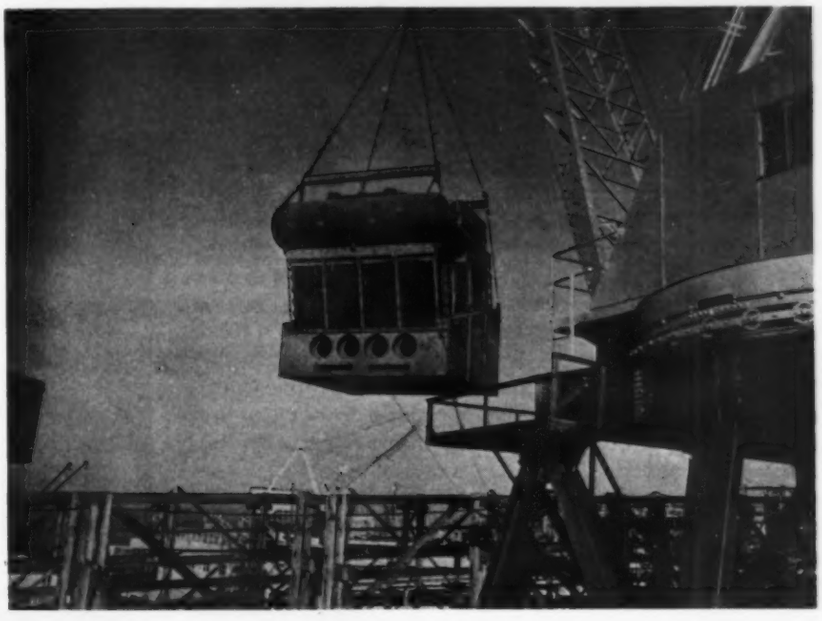


Fig. 3—Lowering assembled boiler from dock to ship

Driven by a single screw, the Liberty ship has a power plant consisting of two oil-fired water-tube boilers supplying steam to a three-cylinder triple-expansion condensing engine, together with the usual auxiliaries required for a plant of this type.

The boilers are of the three-pass sectional-header type, each rated normally at 24,000 lb of steam per hour of which 16,500 lb passes through the superheater to the main engine and 7500 lb is taken direct from the steam drum for operation of the auxiliaries. The maximum steaming rate is 31,250 lb per hr, or 62,500 lb for the two units combined. These boilers are all alike; that is, there are no right- or left-hand units, and they are set with a fore-and-aft firing aisle, at one end of which is the gage board, as shown in Fig. 4.

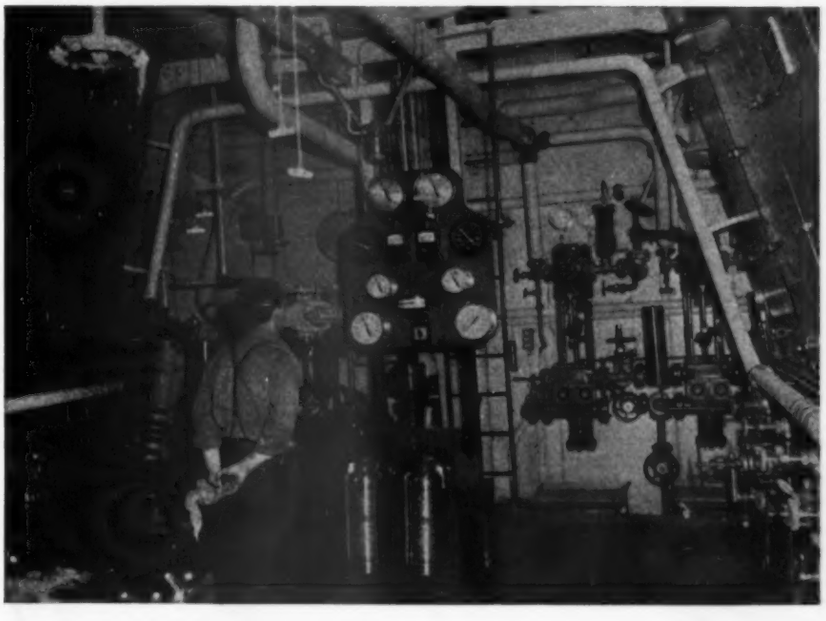


Fig. 4—Firing aisle on one of the completed vessels

The sinuous forged-steel headers are in twenty-two sections, each having a single bottom row of 4-in. tubes and seven groups of four 2-in. tubes. Hence, access to each group of four tubes for internal inspection and cleaning is afforded by a single hand-hole. For cleaning the tubes externally, steam-operated soot blowers are located in the side wall above each pass and below the last two passes. The baffles are of the tight-fitting sectionalized cast-iron removable type and it is possible to withdraw tubes without disturbing them.

Steam is furnished at 220 lb pressure and 450 F total temperature at the superheater outlet. This corresponds to approximately 50 deg of superheat at the engine throttle. The superheater, which is of the convection

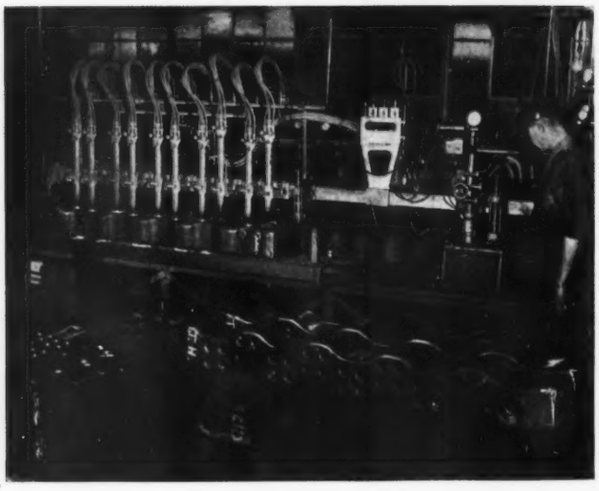


Fig. 5—Work on these boilers is greatly accelerated at one shop by cutting holes in the headers by means of multiple-jet torches

type, is located over and between the first and second passes. No desuperheater is employed. Also, unlike the "C" class of boats being built for the Maritime Commission, the boilers of the Liberty ships do not employ heat recovery in the form of economizers nor automatic combustion control.

Four oil burners of the mechanical-atomizing type are placed in a row along the front wall, the oil being supplied to the burners at a pressure of 150 to 250 lb gage. These burners operate under forced draft. The furnace has a volume of 780 cu ft and when burning approximately 1600 lb of oil per hour at normal evaporation the heat release figures about 38,000 Btu per cu ft. It is lined with superduty firebrick backed by insulating brick and insulating blocks.

From one plant in which a very large number of these boilers are being built the two units for each vessel are transported in three cars. At their destination they are erected on the dock, and then lowered completely assembled into the boiler room of the ship, as shown in Fig. 3.

Feedwater is delivered at 230 F by two vertical double-acting reciprocating pumps and is heated by exhaust steam at 10 lb gage from the auxiliaries. A grease extractor and filter tank form an essential part of the feedwater system.

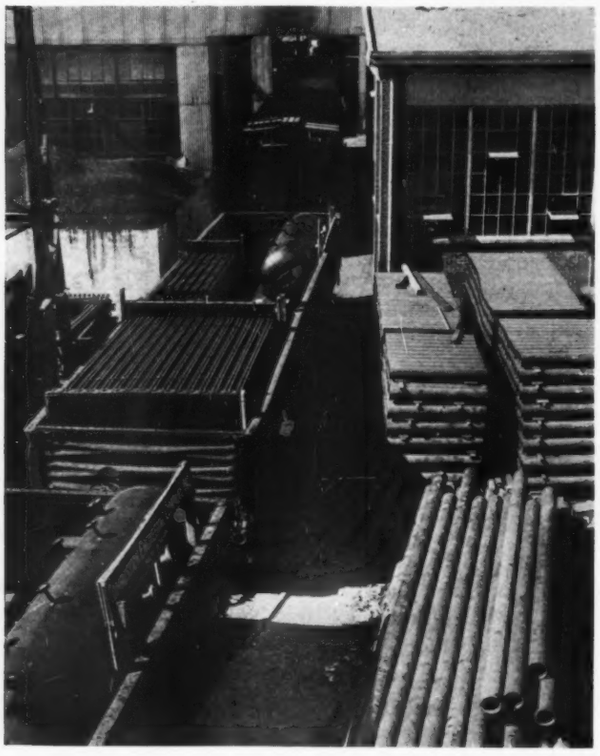
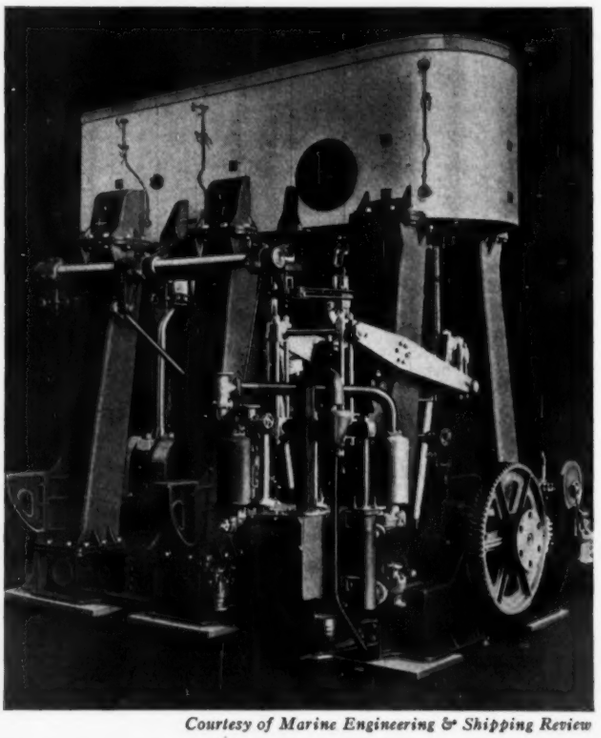


Fig. 6—Headers and drums leaving shop for assembly at shipyard



Courtesy of Marine Engineering & Shipping Review

Fig. 7—Type of reciprocating engine employed to drive Liberty ships

The main engine is of the three-cylinder triple-expansion type, having cylinders 24½, 37 and 70 in. diameter by 48 in. stroke and exhausting to a surface condenser at 26 in. vacuum. These are built in various shops to the same design and specifications.

In addition to the main propelling equipment, the power plant contains two 20-kw engine-driven electric generators supplying direct current at 120 volts, an evaporator plant, a Freon refrigerating plant and various pumps for the circulating, bilge, fire and fresh water services.

By keeping the equipment of these Liberty ships as simple as possible, not only has their production been accelerated but their operation will be simplified, which is important in view of the present demands for marine operating personnel, much of which must be trained as speedily as possible.

Trials of those vessels completed to date are reported to have fully met expectations of the Maritime Commission as to performance.

Dust Problems in Burning Blast-Furnace Gas Under Steam Boilers

By A. R. MUMFORD

Combustion Engineering Company, Inc.

A survey of a number of installations indicates that dirty gas, when not supplemented with other fuels, is satisfactory for burning under boilers, even with refractory settings. When supplementary fuel, such as oil or pulverized coal, is employed, the higher resulting gas temperature may cause the dust to fuse and produce slagging on the heating surfaces. In such cases segregation of the burning zones is desirable. However, the cost of boiler cleaning in such cases is usually much less than that of subjecting the gas to primary washing and appears to justify the use of "dirty" gas.

ALTHOUGH blast-furnace gas is being used for an increasing number of purposes in the steel industry, the greater part of it is burned under boilers for the generation of steam. The next larger portion of the gas is burned in the stoves that heat the blast for the furnaces while lesser portions are burned in soaking pits, with or without enrichment with coke-oven gas, and under coke ovens. Some is still utilized in gas engines driving blowers or electric generators, but this practice is fast giving place to turbine-driven compressors and turbine generators.

The degree to which the gas should be cleaned before being used as a fuel for steam boilers cannot be generalized but must be influenced by local conditions governing the economic efficiency of the combined cleaning and burning operation and because of the differences in local conditions the use of dirty or clean gas in boiler furnaces has long involved a difference of opinion in the steel industry. It is obvious that gas used in engines must be as clean as possible to prevent excessive wear on the valves and reciprocating parts but in soaking pits only partly cleaned gas is used in some cases while thoroughly cleaned gas is used in others. In stoves the use of thoroughly cleaned gas has made possible the use of closer checker spacing or inserts with a resultant lower average flue gas temperature and increased efficiency. Some of the factors bearing on the influence of the degree of cleanliness of blast-furnace gas when burned in boiler furnaces as brought out by discussions with prominent engineers in the industry during visits to their mills are given in the following paragraphs.

Blast-furnace gas is generally cleaned in three stages but special conditions may add one or more stages to the process. The first stage is common to all blast furnaces and consists of passing the gas discharged from the furnace through a modified cyclone which is termed a dust catcher in the industry. In the more modern blast-furnace installations the take-off pipe, from the furnace to the dust catcher, rises vertically, in some cases to a height above the relief stacks, before turning down to reach the dust catcher. The increased lift before the turn causes more of the material, initially in suspension, to drop back into the furnace.

From the dust catcher the practice varies but all or part of the gas is then passed through a washer. Washer design has developed in the direction of increasing height, more effective contact surfaces and greater spray capacity. In one of the plants visited the fine size of the ore (ferro-manganese) made it necessary to operate two washers in series in order to primary wash the gas effectively. In another plant the use of salt water in the washer made an additional stage necessary. The salt water carried over from the washer was removed in a "drier."

Where part or all of the gas is to be cleaned further one of two types of apparatus is usually installed. The most common type is called a disintegrator and is a power-driven washer while the other type of secondary cleaning device is the electrostatic Cottrell precipitator.

Where local restrictions on the contamination of adjacent bodies of water or sewage systems require that the discharge water from washers of both the primary and secondary types be cleared of its dust content before disposal, the usual equipment for this de-sludging process is a Dorr thickener.

In Table 1 the performance of some of the cleaning equipment is indicated.

TABLE 1—PERFORMANCE OF GAS-CLEANING EQUIPMENT

Equipment	Dust—Gr/Cu Ft Entering	Dust—Gr/Cu Ft Leaving	Efficiency, Per Cent
Dust catcher	19.8	6.61	66.6
Washer			
Single on basic iron	6.57	0.257	96.2
Two in series on F-M iron	?	0.95	?
Disintegrator			
On basic iron	0.157	0.011	93.1
On F-M iron	0.95	0.005	99.5
Precipitator			
On basic iron	0.2517	0.00301	98.8

Gas discharged hot from the dust catcher has been found to contain approximately 50 gr of moisture per cubic foot of gas. The cooling occurring in the wet washing process reduces the moisture content to a total of 25 gr of which 10 per cent is entrained. Secondary cleaning by disintegrators further reduces the moisture content to about 10 gr per cu ft.

Some observations of combustion conditions in a "dirty" gas-fired boiler are presented in Table 2.

TABLE 2—EFFECT OF DUST AND MOISTURE IN BLAST-FURNACE GAS ON ITS COMBUSTION

Dust—Gr/Cu Ft	F-M Gas Combustion	Moisture—Gr/Cu Ft
2.927	Poor	36.01
2.243	Poor	...
1.822	Fair	55.31
4.805	Good	56.09
7.406	Very good	42.73

What other factors may have been influencing combustion at the time of these observations is unknown but these observations are not sufficient to indicate conclusively any adverse effect of high moisture and dust contents.

From many data obtained during these visits a fair figure for the operating costs of blast-furnace gas-cleaning equipment seems to be $1 per million cubic feet of gas, equivalent to $0.0139 per thousand pounds of steam made from the gas. The figures that went into this average indicated that at some locations the cost and dust concentration (inversely) were four times the average and at others one-fifth the average. The wide range is probably due to variation in the cost of water and power, because the dust concentrations as discharged from the dust catcher were not widely varying except in those instances where a special ore was occasionally used in some one plant.

Some additional expense is incurred in the cleaning of the mains through which primary washed gas is distributed because of the mud formed by the dust and moisture condensed from the gas in cool or cold weather. The cleaning process consists of hosing down the deposited mud to drip pockets from which it may be dumped to the ground.

The foregoing figures apply to operation only. The investment necessary for the cleaning process will depend upon the degree of cleanliness desired and the quantity of gas to be cleaned to each degree. One well-informed source estimates that if all the gas from one furnace were to be cleaned to 0.01 gr per cu ft the equipment would cost close to half a million dollars. However, if "dirty" gas as discharged from the dust catcher is to be burned under the boilers, only 22 per cent of the total gas flow from one furnace need be cleaned for use in the stoves and a tremendous saving in first cost and fixed charges would be effected.

Observed Conditions

In all plants visited the boiler furnaces were observed and the effects of different quantities of dust in the gas at different plants noted. In one of these plants "dirty" gas from the dust catcher was burned without further cleaning in refractory boiler furnaces. The dust settled out on the bottom and accumulated in a pile to a depth of 3 ft in thirty days. This accumulation was the criterion for taking the boiler off the line for cleaning, although in the interim it was the practice occasionally to poke the dust adhering to the tubes. The dust on the furnace bottom did not sinter seriously and could be removed by hand shovels. No wear was apparent on the burners, nor was it the practice to clean them.

At two other plants primary-washed gas was burned under the boilers and oil was burned as supplementary fuel. The flame in each of these was somewhat clearer and accumulations on the furnace bottoms were materially less than in the first case. However, the dust adhering to the tubes was difficult to remove and complete removal could be accomplished only by hand scraping.

A fourth plant burned blast-furnace gas and pulverized coal simultaneously with horizontally opposed burners in an air-cooled refractory furnace. Here, the point at which the dust in the blast-furnace gas met the ash in the pulverized coal was the location at which slag formed and deposited in the form of a dam which built up in height to several feet. It is possible that the dust in the blast-furnace gas, containing approximately 50 per cent iron, acted as a flux on the coal ash and created a low-temperature slag. Also, it is probable that the high furnace temperature existing with pulverized coal raised the dust temperature well above its fusion point, which would account for adherence of dust to the tubes. Where blast-furnace gas is burned without supplementary fuel, the flame temperature is below the fusion point of the dust. It is pertinent that at another boiler house where only dry-cleaned gas was burned, little trouble was encountered.

At another plant burning primary washed gas with pulverized coal as the supplementary fuel the two fuels were fired through a common burner at a water-cooled refractory target a short distance from the burner discharge. Furnace temperatures did not appear to be much higher than those in which gas alone was burned, probably because only 100 tons of pulverized coal was burned on the average day in the entire plant. Little slag accumulated on the refractory target but the water-cooled furnace tubes had a flaky deposit on them which peeled off on shutdown of the boiler. The lack of serious difficulties arising out of the mixing in the burning of the two fuels may rest in any one of a number of factors or a combination of some of them. Observations indicated that the furnace appearance was about that of a furnace burning gas alone, that the deposit on the furnace bottom was loose and flaky, and that the boilers could be operated for six months without excessive plugging of the gas passages. The amount of excess air, controlled by the speed of blowers on each burner, may have been high and thus maintained the iron in an oxidized condition.

In one plant depending on underfeed stokers for about 80 to 90 per cent of its steam production, some precipitator-cleaned blast-furnace gas is introduced into the furnace through four burners in the rear wall. No cleaning troubles are experienced with the burners which are of special design. Although only a small part of the fuel supply is in the form of gas, significant differences exist between those boilers fired by coal alone and those burning some gas in addition. The external cleaning of the heat-absorbing surfaces requires the same number of man hours in each case but the effect of the addition of gas is shown by the frequency of cleaning. This, for the combination fired boilers, is about twice that for the others. The probability is that the introduction of even the small quantity of blast-furnace dust remaining in precipitator-cleaned gas into a high-temperature furnace, containing cinder in suspension from an underfeed stoker, fluxes the ash in the cinder and causes it to adhere to the heating surfaces in larger quantities and with greater strength.

Another indication of the effect of supplementary fuels was obtained in one plant in part of which so little oil was burned with the gas that the gas could be said to be

the only fuel, whereas on other boilers in the same plant coke breeze was burned on stokers with blast-furnace gas introduced through the front wall above the arches and some coke-oven gas above that. The blast-furnace gas, in each case, had been cleaned by precipitators. Deposits on the heating surfaces in the water-cooled furnace unit burning gas alone were not heavy and could be removed by soot blowers and air lancing, whereas deposits, on the water-cooled rear arch and side walls of the combination fired unit (coke breeze) had to be chipped from the walls to a height of 10 ft.

Even with the small residual dust content in precipitator or secondary cleaned gas, significant differences in operating performances appear when the gas is burned with or without a supplementary fuel.

In those plants which burned primary washed gas under the boilers the burners all required cleaning but with different frequency. Some resorted to poking to remove the partially baked mud, whereas others employed water or steam jets for this purpose. In all cases great care was used to prevent the escape of unburned gas while cleaning the burners.

Costs for boiler cleaning (external surfaces) ranged from $0.000125 to $0.00878 per thousand pounds of steam produced, depending generally upon the dust concentration in the gas.

Where supplementary fuels are available, capacity is often maintained at a sacrifice of efficiency by increasing the amount of supplementary fuel burned. The limit of such procedure is, of course, the complete stoppage of the gas passage with deposited slag. At one of these plants experimental runs were made during the depression years to determine the maximum period between cleanings permitted by the use of blast-furnace gas alone or pulverized coal alone, or a combination of these two fuels. The results indicated that the boiler could be operated six to seven times as long on either fuel alone compared with burning them together. The average loss in capacity between cleanings in four plants of those visited was about 30 per cent.

Conclusions

A study of the data and observations on which the foregoing was based leads to the following conclusions:

(*A*) The use of "dirty" gas unmixed with other fuels is perfectly feasible in boiler furnaces even with refractory settings. The principal operating cost in such furnaces is the removal of dust accumulating from the furnaces and this could be almost completely eliminated by the installation of modern ash hoppers protected by water screens with a modern disposal or handling system. Dust pockets throughout should be amply sized. In such cases flame temperatures are close to or below the fusion point of the dust and further water cooling should be justified on a refractory maintenance basis. This latter promises to be difficult. Adherence of dust to boiler surfaces is not strong and soot blowers should be effective. No burner cleaning difficulties need be expected.

(*B*) The use of primary washed gas makes necessary the cleaning of mains and burners. Usually pulverized coal or oil is burned as a supplementary fuel in such furnaces. Higher furnace temperatures result from the use of a supplementary fuel which causes the residual dust to adhere more strongly to the boiler surface making necessary lancing with water or air mixture and, for thorough cleaning, hand scraping. If the residual dust in the blast-furnace gas makes intimate contact with the pulverized coal ash the fusion point of the mixture is lowered because of the iron content of the dust and slag will form, particularly at elevated furnace temperatures. It is advisable, therefore, to segregate the two fuels into separate burning zones in so far as possible. In such cases the gas should be burned in the lower zone so that the dense and heavy iron dust need not drop through the high-temperature pulverized-coal burning zone before reaching the protection of the water screen. Water-cooled furnaces can be justified on the basis of the higher furnace temperatures obtained with the supplementary fuel.

Obviously, the use of "dirty" gas with pulverized coal would require more careful segregation of the two burning zones. In all cases in which primary washed gas is used the burner should be arranged for easy poking or lancing with provision for shutting off the gas during cleaning. With oil as a supplementary fuel little dust will accumulate in the pits, but with pulverized coal the gas dust will be deposited with the usual quantities of coal ash. Ample provision should be made for the lancing of boiler surfaces in the hotter zones and for soot blowers in the cooler zones.

Some gases contain dusts which appear to be more troublesome than basic iron dust, probably because of the composition of the dust. That produced when ferromanganese ore is used is such a dust. It is reported to be more adherent to boiler surfaces than basic iron dust and greater care must be used, therefore, to lessen the difficulties arising out of the greater tendency of the dust to adhere. The gas may have a 30 per cent higher heating value and a higher flame temperature when burned, causing the dust to be more sticky.

(*C*) Where the use of "dirty" gas is considered or where water is scarce or expensive, the data collected thus far indicate that boiler cleaning, when burning straight gas, can be made so low in cost that the saving over the use of primary washed gas will be large. Furthermore a simple boiler setting, as was suggested under *A*, will suffice in most cases.

Pertinent Oil Figures

The average tanker, according to the American Petroleum Institute, in 1940 carried 80,000 bbl of petroleum or its products and made a round trip to the Gulf or to the Caribbean in 20 days. This was equivalent to the delivery of about 4000 bbl per day. The 1,500,000 bbl carried in a year by a single tanker was about equal to the annual average consumption of 100,000 passenger cars or 35,000 domestic oil burners. In 1941 loadings were greater but complete figures are lacking. Hence, for every tanker sunk or transferred from coastal service, at least the foregoing number of car or oil burners on the Atlantic Seaboard must either get their fuel by other transportation means or, by sharing with other users, get along with less. From these figures one can readily understand how this situation affects oil-fired power-plant boilers.

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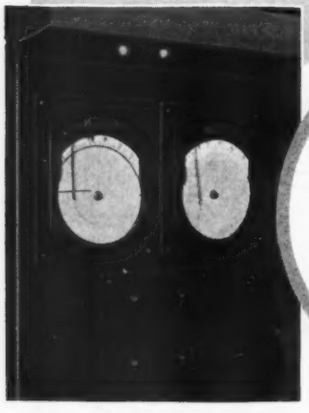
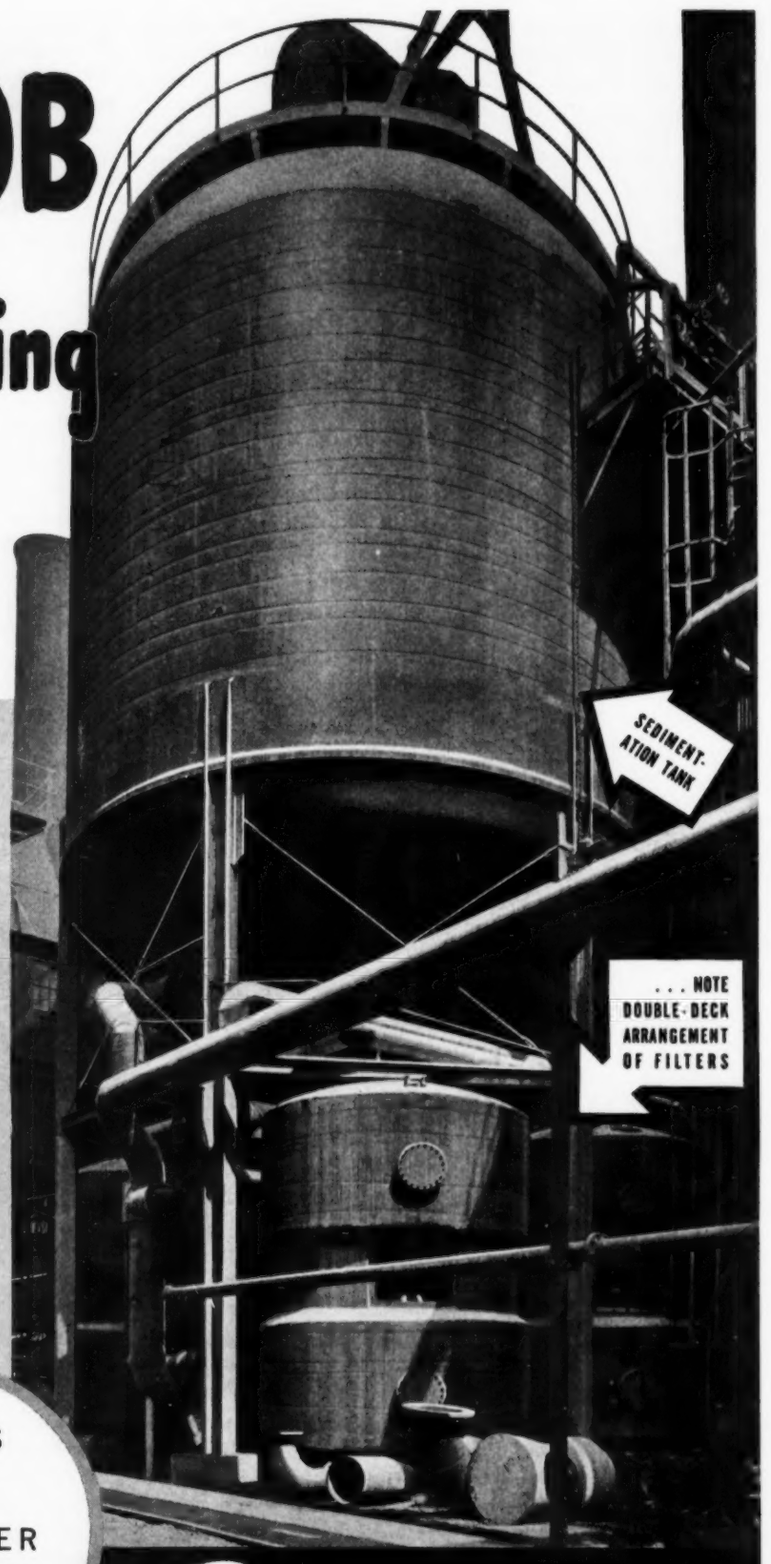


Cochrane Electric Flow Meters control proportioning of chemicals to sedimentation tank



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Power and the War Effort*

By LELAND OLDS

Chairman, Federal Power Commission

The author reviews the technique of power planning and shows how the defense estimates had to be revised to meet the sudden expansion in war production. The effects of population movements and large war plant locations are stressed and power pooling is discussed.

THIS country is fortunate because it is strong in electric power—it is the strongest nation in the world measured in electric power. It is fortunate that when the news of Pearl Harbor was flashed plans were already well along to assure adequate supply of power for an overwhelming defense program. But that does not mean that the power problems of our war effort are all solved, or that a self-satisfied, *laissez-faire* attitude toward further power planning can be tolerated.

Kilowatt-hours, in the huge quantities required by modern war, cannot be mustered without planning. This planning must be on a long range basis because we don't know what year will give us victory. It must provide a margin of capacity over and above statistical forecasts, because no one can predict what may be required of us two years from now. And, because it takes two to three times as long to create new power capacity as it does to create new industrial capacity, power planning may prove a key to winning the war.

Power Planning Technique

Planning the national electric generating capacity needed for war cannot wait until specific demands for power develop. Of necessity the planning must start by determining the capacity required to serve the loads which can now be foreseen. This step must be followed by the more difficult task of allowing for industrial expansion, which may readily take unexpected forms. The appearance of a new weapon, such as the tank in the last war, or the loss of a source of rubber, such as the recent outcome in Malaya and the Dutch East Indies, may change the industrial picture in ways not now predictable. It is not possible, however, to put into operation electric generating capacity with anything like the speed with which a need for that power may arise.

The time required to manufacture and install generating equipment under present conditions precludes any hope of securing more generating capacity in 1942 and 1943 than is now actually on order and it is even doubtful if this capacity will be available as scheduled. Yet, under war conditions, large industrial programs take form rapidly, progressing from the discussion to the operation stage within a matter of months. Furthermore, those planning the industrial program can estimate within narrow limits and can make necessary adjustments in time to avoid serious consequences. On the other hand, the results of low estimates for electric power requirements cannot now be corrected in less than two and one-half to three years. If the tragic story of "too little and too late" is repeated in the power field, the net result would be a delay in the production of vital war equipment, with an attendant loss of life and—quite possibly—of the war itself.

Accurate estimates of national power requirements rest on involved and detailed procedures in investigating the nature and quality of electric loads in each power supply area of the United States. The most important items of basic information are:

1. Complete statistical information on the utilization and supply of electric power by areas for the last 8 to 10 yr. This should include power produced by private industrial generation, as well as by public and private utility systems.
2. Industrial production of each major raw material and intermediate product during the last five years and present and scheduled capacity for each of the next five years.
3. Reliable estimates for each major raw material and intermediate product during the last five years for (*a*) direct war use, (*b*) indirect war use and (*c*) essential civilian use.
4. Estimates of Federal disbursements for the fabrication of finished goods for each of the next five years.
5. Reconciliation of estimated quantities of material for direct war use with the fabrication of these materials in the form of finished goods.
6. Reliable estimates of the wage-earner man-hours required for fabrication of war materials and production of raw and intermediate goods.
7. Electric power conversion factors of kilowatt-hours per dollar value of product and kilowatt-hours per unit weight or measure for fabricated products, raw materials and intermediate goods.
8. Maximum probable operating load factors for each industrial group.
9. Geographic patterns of existing contracts for war materials.
10. Geographic patterns of Army and Navy establishments presently existing and scheduled for construction during each of the next five years.

The estimator must first attempt to reconcile each series of information with all the others so as to supply from his own knowledge close approximations where information is not available. From his careful analysis, he must make authoritative adjustments in the estimated needs and patterns supplied by other agencies. Since electric power is involved in the operation of all in-

*Excerpt from an address before the Midwest Power Conference at Chicago, April 9, 1942.

dustries, and is used by most of the people, the power analyst has the first opportunity and the first responsibility of reconciling estimates made by industrial groups with those made by labor and by financial groups. The power estimator must also examine his own conversion factors to adjust them for probable changes in kilowatt-hours per unit of value, or measure as production for war approaches the limit of national capacity and as deficiencies in labor necessitate greater electrification.

The final calculation of the war industries' energy requirements in each power supply area is made by applying the adjusted conversion factors to the adjusted estimates of expenditures for fabricated war materials and to the adjusted estimates of quantities of raw and intermediate materials required for the war program.

Similar studies should be made for residential, commercial and municipal services. These services can be curtailed with varying degrees of inconvenience, but they cannot be cut off. Their contributions to peak loads on utility systems are of major importance in planning the best use of existing generating capacity and the quantities of new capacity which must be ordered for the war program.

Daily and seasonal load curves must be obtained for each electric power system and studied to determine causes of the varying load shapes during the 24 hours of the day and during each season of the year. These changes are brought about by the different hourly requirements of industrial, residential, commercial and municipal services.

The hourly and seasonal requirements of the combined industrial operations served by a utility system may be broadly grouped in shape or pattern according to fabricating, processing and raw material operations. The power analyst must study curves of industrial operations over the past several years for each of these groups. He must analyze these to determine probable changes in shape or pattern as particular types of industries approach capacity operations. The power analyst must bring to bear a full and comprehensive knowledge of the way each industrial operation has been performed and how that performance can be altered. Thus, he can plan for any necessary modification of normal pattern to obtain the highest possible industrial operation at a minimum addition to the total utility system load.

Shifts in Population a Factor

Population movements, as affected by war industries, training camps and flying fields, must be analyzed to determine where non-industrial loads will increase or decrease in magnitude or shape, out of all proportion to past trends. Rationing and load curtailment may well be included as unavoidable in the overall plan, but serious difficulty will be experienced within a war industry powered by electricity if its workers are denied the use of electricity for essential needs in their communities and homes.

With all classes of service analyzed, the power estimator must assemble all the components in terms of annual energy and peak load contribution. He then builds up a pattern of total load to be served in each area by the generating capacity of all utility systems and private industrial generating plants. Finally, area by area, a comparison of the total load and the total assured capacity reveals the amount of new generating capacity which must be scheduled for delivery in 1944, 1945 and 1946. Only by such means can that inadequacy of power supply be avoided which would result in limiting or crippling the war production program.

Power planning for war or peace goes far beyond the limitations embodied in existing power and industrial facilities. It is fundamentally based on the development of regional resources to a sufficient extent to support a given war effort and the essential civilian participation. It envisages the possible construction of aluminum, magnesium, zinc, copper and machinery industries in new areas where suitable raw materials, transportation facilities and labor are available; selects the most probable of these possibilities and plans the installation of sufficient generating capacity to serve these industrial loads when and where they can be developed. Without such planning, industrial progress in the war effort may be limited merely by the inadequacy of the power supply.

In terms of military strategy, maximum utilization of local resources, best mobilization of man-power, prevention of transportation congestion, etc., these expansions of the country's productive power may be located in areas not previously industrialized. The voice of private commercial interest no longer is decisive. As a result, war power planning must fully appraise the potentialities of all areas for development of war industry in terms of power supply which will make possible the placing of industries in presently rural or semi-rural communities.

Efforts to Assure Adequate Power Supply

The Commission has been carrying on this power planning work intensively since 1938. This planning has been constantly kept up to date with the changing conception of the magnitude of the war effort. It has increasingly emphasized the fact that victory will require a war effort limited only by the country's resources.

This power planning has tested the adequacy of existing and projected power supply, not only on a country-wide basis but in terms of each of the forty-eight power supply areas into which the country has been divided. It has considered each power plant, steam or hydro, to determine its dependability under varying circumstances and in relation to changing conceptions of load. It has measured and appraised such limiting factors as boiler capacity, availability of condensing water, seasonal changes in temperature of condensing water, variations in stream flow, possibilities of overload, etc.

The power planning has also considered the minimum reserves required for dependable operation, the extent of interconnection, the possibilities of reducing reserve requirements through further interconnection, the provision necessary to provide against the possibility of outages of generating capacity due to wear and tear or hostile acts. And it must be borne in mind that the necessity for long-sustained operation of steam units tends to increase the possibility of such outages.

Down to the spring of 1941 the Commission was using its estimates of power supply required by the defense program as a basis for conferences in which the power systems serving each power supply area were urged to consider ordering the additional generating capacity indicated to be necessary to meet the requirements. It

was also recommending the construction by the Government of specific river basin projects which included power adapted to meeting defense needs in the most economical manner.

By that time, however, it had become apparent that the most effective use of the country's capacity to produce turbine-generators, as well as the need for overall allocations of essential materials, required a long-range plan indicating the specific additions to generating capacity which would be required to assure the defense program against curtailment due to power shortages. In July 1941, the Commission presented such a plan to the President. In presenting the plan it called attention to the fact that in the eighteen months from January 1, 1940, to June 30, 1941, orders had been placed for 6,341,000 kw of new capacity. Its plan called for additional orders which would bring the new capacity on order for installation in 1943 up to about 3,500,000 kw and would assure continuation of new installations through 1944, 1945 and 1946, at approximately that rate.

The planned additions to generating capacity included about 2,500,000 kw annually of new steam units and 1,000,000 kw annually of new hydro units. This division, between steam and hydro, was determined entirely by the availability of capacity to produce units in the several electric equipment manufacturing companies.

Effect of Expanded War Expenditures

The program was based on the assumption that by 1943 defense expenditures should be running at an annual rate of $36,000,000,000; that approximately half of this program would represent displacement of normal civilian supply; that, even using manufacturing capacity to the limit, the total loads in 1943 and 1944 could be carried only by cutting heavily into reserves and by considerable civilian curtailment in certain areas; and that if the war should continue into 1945 and 1946 provision would unquestionably have to be made for still further expansion of the defense effort.

Now we are at war. Pearl Harbor, with all that it signifies, has brought the country face to face with that further expansion of the war production program. We cannot afford to wait until 1945 or 1946 for a program involving war expenditures at the rate of from $50,000,000,000 to $60,000,000,000 a year. We face annual energy requirements of about 150,000,000,000 kwhr for the war program, including direct and indirect war production as well as war service needs.

For purposes of comparison we may recall that for the year 1939, before the defense program had got under way, the production of electric energy for public use was only 130,000,000,000 kwhr. Assuming that war production will displace about half of the industrial production of that year for civilian purposes, there still remains the problem of assuring that by the time the war program is in full swing it can command about 125,000,000,000 kwhr over and above those produced in 1939.

The Tennessee, Columbia and Colorado River developments are today accepting responsibility for critical war loads. According to present programs the production of aluminum and magnesium in 1943 will require 1,755,000 kw from Federal plants on these rivers. Other war industries will require an additional 1,000,000 kw from the same source. The real question is where would we have been in terms of production of the most critical materials if it had not been for the ability of these developments to expand rapidly to meet unanticipated requirements?

The Commission's recommendations, for construction of hydroelectric plants or installation of units at existing dams as parts of the war program, are based on long studies of the possibilities of comprehensive developments in these basins. They include only projects adapted to carrying the war loads of their respective areas on a basis at least as economical as equivalent steam power. And they offer the advantage of releasing the definitely limited capacity to produce steam turbine-generators, with their essential forgings and castings, to meet the requirements of other areas where hydro is not available, or of the naval and maritime programs. In a number of instances they also offer very considerable benefits to existing downstream power developments, flood control benefits to essential war supply areas, improved navigation depths for the transportation of war goods, and in other ways promote the war effort.

In general, these hydro projects as proposed can be constructed in a time comparable with that required, under present labor and priority conditions, for the installation of equivalent steam capacity.

These highlights of some of the more controversial of the water power recommendations should be supplemented by one further suggestion. It is certain that multiplication of steam generating capacity, as the war effort progresses, will face increasing problems of fuel supply. This will be due not only to increasing demand for the various fuels but probably even more to increasing pressure on the country's transportation systems. If, unfortunately, the war should prove long, the more water power that can be brought into the program, the less danger there will be of serious interference with power production due to fuel shortage. It is already apparent that transportation of fuels, both coal and oil, next winter will be a serious problem in some important areas.

Power Pooling and Curtailment

The possibilities of regional power pooling were given a thorough tryout in the efforts to deal with the power shortage in the Commonwealth & Southern and Tennessee Valley Authority areas in the Southeast during the months from June to November 1941. The situation became acute because of the tremendous expansion in the energy requirements of the Aluminum Company and an expansion of loads on the private systems that greatly exceeded their expectations, coupled with the most serious drought in the history of the region.

As a result of power pooling arrangements involving power systems in 17 states, it was found possible to increase emergency deliveries of energy into the drought area from a rate of 18 million kilowatt-hours a week, when the first conference was held on May 20, to a rate of 28 million kilowatt-hours a week by May 25 and 33 million kilowatt-hours a week by July 2, when some rains temporarily relieved the situation. When the situation again became critical in the autumn, such transfers of power were raised to 51 million kilowatt-hours a week in late October and finally to 64 million kilowatt-hours a week in early November.

These increased deliveries of power as a result of pooling meant, in the main, more complete utilization of

steam generating capacity in certain areas to prevent draw-down of reservoirs in the drought area. It was made possible by an overall knowledge of the capabilities and loading of all the generating stations in the region, coupled with information as to the maximum possible transfers with existing transmission facilities. In some instances actual tests were necessary to determine the limits to which these deliveries could be pushed.

This experience in the Southeast, which will probably be repeated in other regions if the demand for power rises, raises the question whether much greater co-ordinated operation of wholesale power facilities on a regional basis is not needed.

The experience with curtailment in the Southeast, attempted so far as non-essential industrial load was concerned, only on a voluntary basis in the Commonwealth & Southern area, provided three important suggestions: (*a*) that careful study of the possibilities of shifting the incidence of various loads can achieve a considerable saving in power without requiring actual curtailment of production; and (*b*) that there are definite limits to the savings in load which can be obtained by this method; and (*c*) that the measures to be used must be carefully chosen to suit the needs of the area in order to prevent undue hardship without compensating benefits.

Conclusions

Subsequent studies of load control measures have resulted in certain tentative conclusions which may be briefly summarized as follows:

1. Almost all forms of commercial use of energy contribute to the evening peak, and residential use at the time of evening peak is generally rising rapidly toward its maximum peak which occurs about 9 o'clock.
2. The addition of the second shift and overtime work of hitherto single-shift industries adds large loads to utility systems' evening peak loads without requiring additional industrial facilities.
3. The combined effects of "war time" and restrictions upon commercial use, supplemented by restrictions upon industrial use during the evening hours only, could reduce the evening peak to the levels of the morning load. This would be accomplished without interfering with the total volume of industrial production and without seriously affecting the habits of the people.
4. In some areas there is no need to reduce the evening peak to morning levels because the power supply may be from hydroelectric plants having limited amounts of energy available but plenty of capacity.
5. Omitting these areas, the aggregate reduction in peak load by the measures indicated above would be at most two and a quarter million kilowatts, of which about 800,000 kw reduction has already been obtained by the institution of "war time."
6. Further reduction in load would have to be obtained at the expense of uses contributing to the load levels prevailing from 8 a.m. to 8 p.m., involving serious effects upon industrial operations.

Finally, it should be emphasized that war power planning must be integrated into the broader problem of total war production planning. Donald M. Nelson, Chairman of the War Production Board, has that tremendous responsibility. The possibilities of expanding generating capacity or transmission facilities are related to the possibilities of expanding all other lines of war production, because all lines are competing for raw materials, manufacturing capacity and man power. This means that decisions may go against the conclusions reached by those interested in any single line of production. For the objective must be a balanced program which will enable the nation to exert to the full its great industrial strength in the world conflict.

Pulverizing Coal by Steam Explosion

The production of finely pulverized coal upon principles similar to those used in making "Puffed Wheat" has been demonstrated at the Armour Research Foundation in a program of research recently sponsored by the Peabody Coal Company, Chicago, Illinois. As reported in the April issue of "Bituminous Coal Research," coal was shot from guns in which it had been subjected to steam at high temperature. When the pressure in the gun is suddenly released, the pressure within the coal pores explodes it into small particles.

Early experiments were made with a sealed tube filled with coal and water, and designed to rupture at one end when heated externally to a preassigned pressure. Results were so promising that a new tube was built with a hydraulically-operated quick-opening valve, and furnished with high-pressure steam under controlled conditions which made it possible to study the effect of steam pressure, time of soaking and quickness of release on the yield of fines obtained. Discharge of coal against a target increased pulverization.

By subjecting the products of one expansion to another expansion, the same yield ratio of fines was obtained, and the ratio maintained in successive explosions. This feature of the process makes possible the introduction of classifiers and separators to control the size of the final output.

In one of the tests made, $^{5}/_{16}$-inch by 6-mesh Illinois coal was exploded by steam at 900 lb pressure, air classified and size-separated for re-cycling three times, and gave a final cleaned product having the following screen analysis:

On 60-mesh	0.1 per cent
On 60 by 100-mesh	5.4 per cent
On 100 by 200-mesh	28.9 per cent
Through 200-mesh	65.6 per cent

Finer pulverization could have been obtained by additional cycles.

Coals vary widely in their porosity and further experiments on coals from other fields remain to be tried. Large scale tests must also be made to establish the comparative costs of this system with that of mechanical methods. For a commercial application, the steam consumption is calculated to range between 106 and 151 lb per ton of coal pulverized.

A slow release of the steam pressure caused the coal to expand permanently into a highly porous structure. When the coal was heated to the plastic range in an atmosphere of steam, a caked mass resembling semi-coke resulted. Furthermore, in view of the fact that impurities such as bone and pyrites are less porous than the coal substance, the possibility of reducing the ash content of the coal in the new method of pulverization is another incentive to the development of the process.

What About Your Coal Pile?

In these excerpts from an address before the recent Annual Meeting of the U. S. Chamber of Commerce, Mr. Gray reveals the load that has fallen upon the railroads through the transportation of oil to the Eastern Seaboard and the breakdown of water-borne coal shipments to New York and New England; this in addition to heavy shipments of war materials. To avoid fall and winter peaks that might tend to cripple the transportation system and result in the setting up of a governmental system of coal allocations, he urges users to build up present stocks so as to spread the year's requirements for production and transportation more evenly over the twelve months.

By HOWARD A. GRAY

Acting Director
Office of Solid Fuels Coordination

COAL customarily is bought only as it is needed. Usually, only a minimum amount is carried in storage, and consumers depend upon the mines and carriers to maintain a continuous flow of fuel to meet current requirements. Such a practice causes seasonal peaks and depressions in coal production and transportation. This is a dangerous practice in wartime, when disruptions in the flow of coal can be expected.

The war is handicapping both the production and transportation of coal. In production, mine operators are confronted with reduced labor supply and shortages of such materials as steel, copper and rubber, which are used in large quantities by the mining industry. In the transportation of coal, which appears to present the more pressing problem now, we are confronted by the possibility that the Nation's carriers may be unable to meet peak demands this fall and winter.

A study of seasonal variations shows that during the fall and winter months coal is produced at a peak rate greatly in excess of the average monthly requirement for the year. On the other hand, during the spring and summer, when a large part of the mine capacity is idle for lack of coal purchasers, the production rate is considerably below the average monthly requirement. Coal transportation follows this same general pattern.

The seasonal peak in coal production and the seasonal peak in general freight transportation generally coincide. In fact, the heavy coal tonnage during the production peak is one of the important factors that build up the seasonal peaks in total railroad car loadings.

The 1942 coal production and transportation requirements are expected to exceed those for any recent year. No one can predict definitely how much coal will be required this year, but it now appears that from 550,000,000 to 570,000,000 tons of bituminous coal and approximately 60,000,000 tons of anthracite may be needed. This would necessitate a production rate averaging around 11 million tons per week for bituminous coal and about 1,150,000 tons per week for anthracite. Every week that the production and transportation of coal falls below those figures means that additional coal must be mined and hauled during some other week to make up the deficit.

If the 1942 fall production peak is built up to customary proportions, based on this year's war-increased needs, the railroads may find it difficult to move coal as required and delayed coal shipments may be expected. Hence, those not adequately prepared to continue operating out of their coal in storage may expect a fuel shortage.

Mines and the carriers, in the face of the handicaps imposed by this war, cannot be expected to keep on supplying coal in the uninterrupted flow to which we have been accustomed at all times in the past. Already they are experiencing difficulties, and conditions will get much tighter than they now are before this war is won.

Effect of Shortage in Other Means of Transportation

In considering what is confronting the railroads this year, it is well to bear in mind that they will have to move a still greater part of our coal than they have in the past. This is due to the effects of the war on shipments by other types of carriers, such as ocean colliers and motor trucks, and the increase in coal demand occasioned by conversion from the use of other fuels to the use of coal because of the shortage of the other fuels.

It might be interesting to give some figures to illustrate how increased railroad burdens resulting from changes in the movement of fuel are eating into the limited transportation facilities. For instance, it now requires about 600 more freight locomotives every day to haul oil into Eastern Seaboard states than it took before the present petroleum emergency. Furthermore, it has been estimated that it will take about 150 additional locomotives to haul coal all-rail from the Southern Appalachian field into New England than it would take to haul that coal via the rail and tidewater collier route. The size of these figures, which represent new demands upon rail equipment that were not expected heretofore, is emphasized when they are compared with the fact that one of the Nation's major coal-carrying railroads has less than 600 freight locomotives in its entire engine ownership. Furthermore, the 1942 railroad locomotive construction program called for 900 engines to be built. This is only 150 more engines than the additional 750 which will be needed to meet this new Eastern Seaboard fuel situation alone.

The locomotive situation is not all of the story. It will require 6000 additional coal cars for the all-rail movement from the Southern Appalachian field to New

England, than it would take if the usual rail-water haul were used. Consider this in the light of the fact that before these new situations occurred, railroad authorities had estimated that there would be a shortage of approximately 33,000 freight cars of all types under the amount of equipment that would be required to handle the 1942 freight traffic peak.

A no less complicated situation is presented by the shipments from the Appalachian field, via rail to Norfolk, and thence to New York and New England by collier.

This brings us to the question of why the Government is warning the country to buy coal now and store it as insurance against possible shortages that might result from the effects of the war on coal production and transportation.

Serious shortages of coal or transportation might materially impede the military program, and help to prolong this world conflict. Hence, it is imperative that we do our utmost to prevent such a shortage. The importance of coal in the war program cannot be overemphasized. There is no other single commodity that is more basic. Half of the Nation's energy originates from this single fuel. Furthermore, any increase in energy must come from coal, and the present shortages of fuel oil, natural gas and hydro power must be offset by coal. Aside from war requirements, coal also is vital to our civil life.

The Office of Solid Fuels Coordination and others have been cooperating in urging the production and storage of coal during the off season. Recent statistics indicate that many consumers are responding. At the same time, there are still many who show little or no interest in protecting their own fuel supply. These persons and companies are not making the fullest contribution they could to winning this war.

Whose coal shipments will those improvident users who ignore warnings to take adequate precautions, want the Government to seize and turn over to them to keep them going in an emergency? Will you have enough coal in your own stockpile to keep operating if the coal you thought you had on the way to you is diverted to somebody else who had failed to stock up? Will you, too, have to ask for help, and want somebody else's coal? Such a chain of circumstances could quickly create a serious emergency.

Although in some instances purchasers already are finding it difficult to obtain coal for their storage piles, time and facilities still are available to produce a great deal of coal for storage during late spring and summer, before the presently available surplus in facilities is wiped out by the effect of the war and the customary peak demand. It is imperative, in the interest of maintaining the drive to win this war, that every coal mine and coal carrier be enabled to operate at top capacity for the rest of the off season. This cannot be done unless buyers order their coal now, and store it for future needs.

I cannot tell individuals how much coal they should store but, in general, a supply adequate for 60 to 90 days is not too much for the ordinary industrial consumer to have on hand. Public utilities and vital war industries ought to carry coal enough to last at least 120 days. Householders should store their entire next winter's supply this summer, if that is possible. The coal in storage now generally does not even approach these figures.

Protective storage of coal will pay big dividends. True, it costs more money to store coal and in a great many instances it is inconvenient. But it will prove to be more economical and satisfactory to store coal than it would be to get caught by a shortage, or to try to operate on the kind of coal one might be forced to use if the Government found it necessary to institute an emergency distribution system.

From time to time I have heard expressions attributed to coal users asking why they should go to the trouble and expense of storing coal when the Government would see that they got it should a shortage occur. Some people who have that idea may be due for a very great surprise. They may get an emergency fuel distribution system, but I don't believe they are going to like it or the kind of coal it might give them. The best zoning or allocation system that could possibly be devised would be an unsatisfactory substitute for orderly, natural coal distribution.

Although the Office of Solid Fuels Coordination is now working out an emergency coal distribution system, it will be recommended for use only as a last-resort measure, after all other efforts to keep essential users supplied have failed. But, when the need for such a system is apparent, it will be recommended without delay.

The best and only way to delay or avoid the necessity for having to institute such an utterly undesirable system, which may become necessary, is to get the greatest amount of coal possible into the storage piles now, while it can be moved. Then keep the piles replenished, as fast as the coal is used.

EQUIPMENT SALES

as reported by equipment manufacturers to the Department of Commerce, Bureau of the Census

Boiler Sales

Stationary Power Boilers

	1942 Water Tube		1941 Water Tube		1942 HRT Type		1941 HRT Type	
	No.	Sq Ft*	No.	Sq Ft*	No.	Sq Ft	No.	Sq Ft
Jan.....	202	1,637,588	170	968,275	53	61,990	89	123,459
Feb.....	238	1,557,004	97	847,331	59	84,660	81	104,622
Mar.....	326	1,520,654	200	988,037	166	92,999	86	89,324
Jan.-Mar. Incl....	766	4,715,246	467	2,803,643	278	239,649	256	317,405

* Includes water wall heating surface.

Total steam generating capacity of water tube boilers sold in the period January to March (incl.), 1942, 38,327,000 lb per hr; in 1941, 29,378,000 lb per hr.

† Mechanical Stoker Sales

	1942 Water Tube		1941 Water Tube		1942 Fire Tube		1941 Fire Tube	
	No.	Hp	No.	Hp	No.	Hp	No.	Hp
Jan.....	87	42,876	77	41,975	‡159	‡24,135	94	14,036
Feb.....	131	55,001	60	27,736	185	26,889	117	14,774
Mar.....	84	46,005	69	31,342	212	33,395	146	21,552
Jan.-Mar. Incl...	202	143,882	206	101,053	556	84,419	357	50,362

† Capacity over 300 lb of coal per hr. ‡Revised.

Pulverizer Sales

	1942 Water Tube No.			1941 Water Tube No.			1942 Fire Tube No.			1941 Fire Tube No.		
	(N)	(E)	Coal Lb/hr	(N)	(E)	Coal Lb/hr	(N)	(E)	Coal Lb/hr	(N)	(E)	Coal Lb/hr
Jan.....	102	3	1,071,340	39	—	462,990	—	—	—	—	1	1,000
Feb.....	21	1	246,520	42	4	734,200	—	—	—	—	—	—
Mar.....	31	7	360,620	31	3	739,700	1	—	13,000	—	—	—
Jan.-Mar. Incl....	154	11	1,678,480	112	7	1,936,890	1	—	13,000	—	1	1,000

(N)—New Boilers; (E)—Existing Boilers.

STORAGE OF BAGASSE

By G. H. ROUNTHWAITE*

To answer the question as to the liability of spontaneous combustion with bagasse in storage, the author cites the results of investigations which showed the temperature rise to be far below the ignition point. It is concluded, therefore, that such cases of spontaneous combustion as have been reported, were probably due to external causes.

MANY of the sugar cane factories in Hawaii store piles of bagasse which is not used up as it accumulates, with the result that the earlier quantities stored are often not reached for burning in the boiler furnaces until the end of the grinding season—a period averaging around twelve months. Some of the old timers have held the opinion that this presented a hazard from spontaneous combustion, but there appears to be little, if any, evidence to confirm this belief and it is probable that such fires as have occurred have come from sparks, cigarette butts or other outside causes.

Inasmuch as there is always a disposition to ascribe to spontaneous combustion the cause of a fire of unknown origin, it may be well to consider what constitutes spontaneous combustion and what substances are capable of producing it. The phenomena occur only in substances liable to (1) oxidation, (2) volatilization or (3) fermentation.

There are certain oils that come under the first class. These are the drying oils which are capable of absorbing oxygen and which, under certain conditions, are capable of spontaneous combustion. Non-drying oils, however, are not, and within this group fall most of the oils and fats used as lubricants. Woolen rags are most liable to spontaneous combustion, cotton waste only to a limited extent and jute waste not at all. Waste saturated with linseed oil is very liable to spontaneous combustion due to its affinity for oxygen.

Results of Investigation

Some years ago an intensive study was made in the Territory to determine the point at which ignition of bagasse would occur. Tests were made with bagasse dust, fine bagasse and bagasse of the ordinary composition after grinding through a 15-roller mill. The samples showed the points of ignition as follows:

Bagasse dust	325 F charring	475 F ignition
Fine bagasse	340 F charring	500 F ignition
Ordinary bagasse	350 F charring	550 F ignition

These figures were the averages of a large number of determinations with moisture ranging from zero to 60 per cent and sucrose from zero to 10 per cent, the higher sucrose figure being obtained through the addition of molasses to simulate extreme conditions that might arise. It was found that the addition of molasses, up to 8 per cent sucrose, increased the ignition point.

It remained for the investigation to determine the heat inside piles of bagasse and the temperature changes occurring in bagasse while in storage. Hence, two bins were erected, each containing 100 cu ft and filled with fresh bagasse The bulb of a recording thermometer was inserted in the center of each bin. One contained bagasse from a 21-roller mill with 44 per cent moisture and 2 per cent polarization, and the other bagasse from a 12-roller mill with 48.2 per cent moisture and 4.73 per cent polarization.

Inside of 24 hr the temperature had increased to approximately 110 F and in 3 days to 120 F, at which point it remained constant for 3 days more and then rose gradually to a maximum of 141 F. After remaining at this point for about a week it began to drop. The total rise from the temperature of the bagasse as it left the mill was less than 60 deg and it was still 240 deg under the ignition point.

Final Temperature Far Below Ignition Point

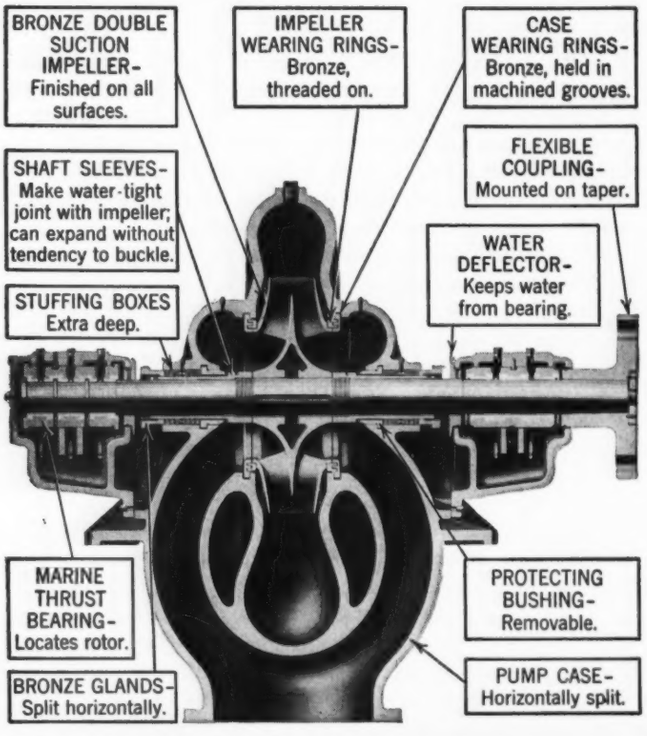
The investigation was carried still further by building two silos which were filled with bagasse, sealed and connected to a gas collector. It was found that during the first 3 days a considerable amount of CO_2 was given off; this reaching the peak on the second day, but during this period there was no observable increase in temperature. At the end of 15 days one silo was unsealed and its contents exposed to the air; and into the second silo a stream of oxygen was introduced. In 11 days the temperature in the open-air silo increased 13 deg and that in the second silo 5 deg. The maximum temperature reached in either was 93 F. The conclusion reached was that the temperature rise was due to oxidation slightly influenced by fermentation, but there remained no doubt that, although complex reactions apparently occurred, these did not produce a temperature rise suggestive of danger.

Practically all the cane sugar mills in Hawaii utilize bagasse as their main, and sometimes only, source of fuel. It has been considered a waste by-product and its disposal by burning under boilers for the generation of steam has offered the most economical solution. More extensive use of bagasse in the manufacture of paper, wallboard and other cellulose products may in time make it profitable to sell this by-product and with part of the proceeds purchase standard fuel for steam generation. However, for the present, the use of bagasse for steam and power generation for mill and outside use gives it a definite value and the oil or coal equivalent represents a definite cost.

* Mechanical Engineer, W. A. Ramsay, Ltd., Honolulu, T. H.

SUSTAINED EFFICIENCY

OF DE LAVAL PUMPS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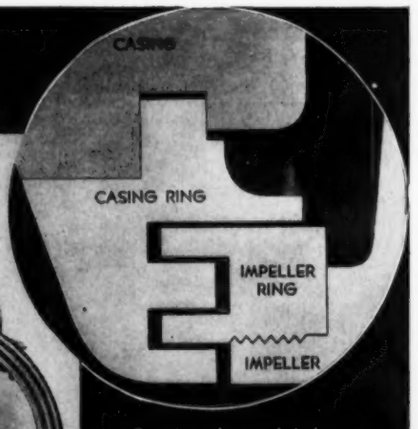
Labyrinth case protecting ring.



Section through labyrinth wearing rings.

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STEAM ENGINEERING ABROAD

As reported in the foreign technical press

Changing Fuels

Industrial plants in England have been cautioned against converting their boiler plants to the burning of different fuels without first consulting the appropriate fuel department of the government or Board of Trade, which will advise in accordance with available fuel supplies. This also applies to the installation of a new power plant.

The motive behind this action is the conservation of labor and materials and the allocation of fuel supplies in accordance with the prevailing situation.

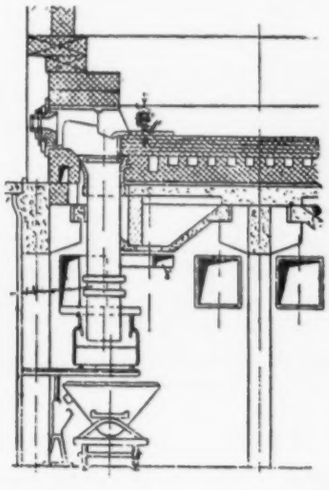
To bring about a reduction in the use of fuel oil which has to be imported under difficulties, the British Government is urging many oil-burning plants to burn a mixture of creosote and pitch of which considerable quantities are available. A number of plants are already in the process of making this change.

Slag-Tap Furnace With Peat

Frederick Alton, writing in the *Engineering and Boiler House Review* of March 1942, discusses progress that has been made in the burning of peat under power boilers in the Soviet Union, particularly in pulverized form and with a slag-tap furnace.

It is estimated that the aggregate capacity of peat-burning power stations in Russia is about a million kilowatts and the maximum boiler size to which peat firing is at present applicable is about 350,000 lb of steam per hour.

The peat so burned averages 25 to 40 per cent moisture as fired, 4 to 15 per cent ash on a dry basis, and 2790 to 6600 Btu per lb as fired. The peat ash is readily fusible; deformation begins at 1895 F, softening at 2039 F and fusion at 2102 F.



Sketch of slag tapping arrangement at the Kalimin Station

While much of the peat is fired as lump on chain grate stokers, during the last ten years the trend has been toward employing milled peat. In some cases this was fed to the furnace to form a layer over the lump peat on the stoker but this was found to reduce efficiency because of incomplete combustion.

A later development has been the burning of peat in suspension at the Klasson Power Station in which the shredded peat is fired through the front arch with preheated air of 586 to 761 F, depending on the steam output, and the desired turbulence is attained by means of air jets through horizontal ports in the furnace walls at 40 to 45 lb pressure. The furnace has water walls and the bottom consists of a metal base plate upon which are placed two layers of red brick, then an air box for cooling with compressed air at 28 lb which discharges into the furnace through ports in the rear wall; and over the air box is a second steel plate carrying 8 in. of dolomite and 5 in. of magnesite. Some flue gas is withdrawn from the furnace through the slag discharge ring in order to maintain the slag above the solidification point.

Another such installation, described by the author, is that at the Kalimin Station where the original dry bottom furnaces were changed over to slagging bottoms because of trouble from large slag accumulations. This installation employs refractory furnaces and a sketch of the slag tapping arrangement is here shown.

War Damage to Plants

The Power and Works Engineer published in its March 1942 issue an abstract of a paper read by Hal Gutteridge before the Institution of Mechanical Engineers, England, which dealt with the liability of plants to damage from enemy action.

Experience has shown that damage to plant equipment depends upon the protection given it by the building, and first observations with regard to possible damage should concern (1) the site, (2) construction and state of the building, (3) the walls, roofs and floors, and (4) the drainage. Damage is likely to be least where the building is of steel or reinforced concrete construction forming one structural unit. Composite types of brick and steel-beam construction require adequate bracing to prevent "spreading collapse." Walls 14 in. thick will protect the interior from flying splinters and debris. Solid concrete floors and roofs strengthened with filler joists are superior to floors of hollow tile or other light-weight construction. Frequent sources of danger are insuf-

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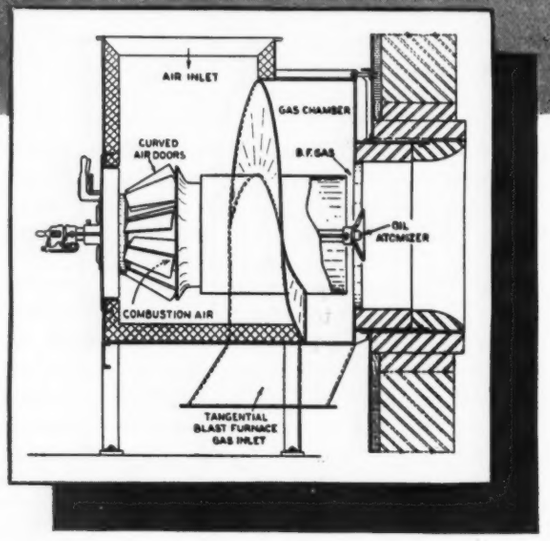

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ficiently protected elevator shafts and light wells, and confined spaces between buildings. Adequate drainage facilities to cope with abnormal quantities of water when fighting fires will reduce damage to a plant at, or below, ground level.

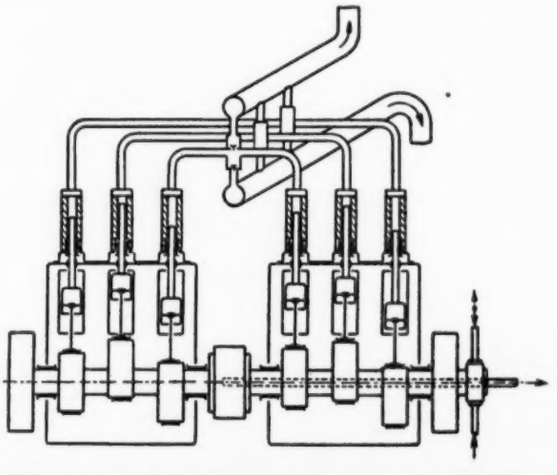
The causes of plant damage from air attack are: (1) a direct hit from a high-explosive bomb, (2) a blast pressure wave from explosion accompanied by flying splinters and debris, (3) fire caused by incendiary or high-explosive bombs, (4) falling debris, (5) flooding or drenching by water. Each item of plant equipment is susceptible to damage according to its physical characteristics which can be tentatively assessed beforehand and, as suggested by the author, a "damage proneness number" (d.p.n.) assigned. For example, a blacksmith's anvil would have a minimum proneness to damage, whereas recording and control equipment would have a high proneness to damage from any of the above causes. Heavy equipment such as rolling mills, large presses, etc., will have a low d.p.n. value, and light high-speed machines a high value.

It cannot be too strongly impressed that supply piping and services are the arteries to the machines. Improvements should be sought as follows: (1) Length of service lines should be as short as possible; (2) piping should be duplicated within reasonable limits, avoiding the possibility of one bomb destroying both lines; (3) adequate protection should be given by placing piping underground, or in other ways. Cables for the supply of electricity should be duplicated and run in watertight channels with vertical leads to the points of consumption.

Fire-tube boilers generally offer a high ratio of weight to exposed area, and may be given a d.p.n. between 10 and 30; whereas water-tube boilers with a high center of gravity may lie between 40 and 70.

Feed Pump for Once-Through Boilers

In view of the sensitivity of drumless once-through forced-circulation boilers to load fluctuations, it is necessary to provide very sensitive and accurate control for both the feedwater and the fuel over the entire load



Arrangement of variable feed pump as applied by Sulzer Bros.

range. The April issue of *Engineering* and *Boiler House Review* describes a means of securing such control with a reciprocating pump driven at constant speed in which

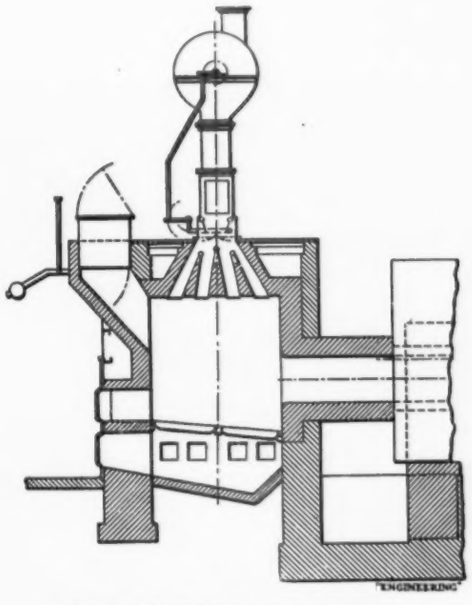
the pump is divided into two cylinder groups with separate crankshafts. The relative angular positions of these crankshafts are adjustable by mechanical means during operation. By connecting corresponding cylinders of the two groups to joint valve chests, the output of the pump at constant speed is made a function of the relative angular positions of the respective cranks. An infinitely variable output over the entire load range is thus obtainable with little loss in efficiency.

The first application of such a pump arrangement appears to have been made several years ago in connection with the large Ramsin boiler at the Moscow Thermotechnical Institute, but quite recently Sulzer Bros., Switzerland, has brought out a feed pump operating along these lines.

In the Russian installation, adjustment of the relative crank angularity was accomplished by a planetary gear device, but this is now superseded by an oil pressure coupling.

Burning Wood Refuse

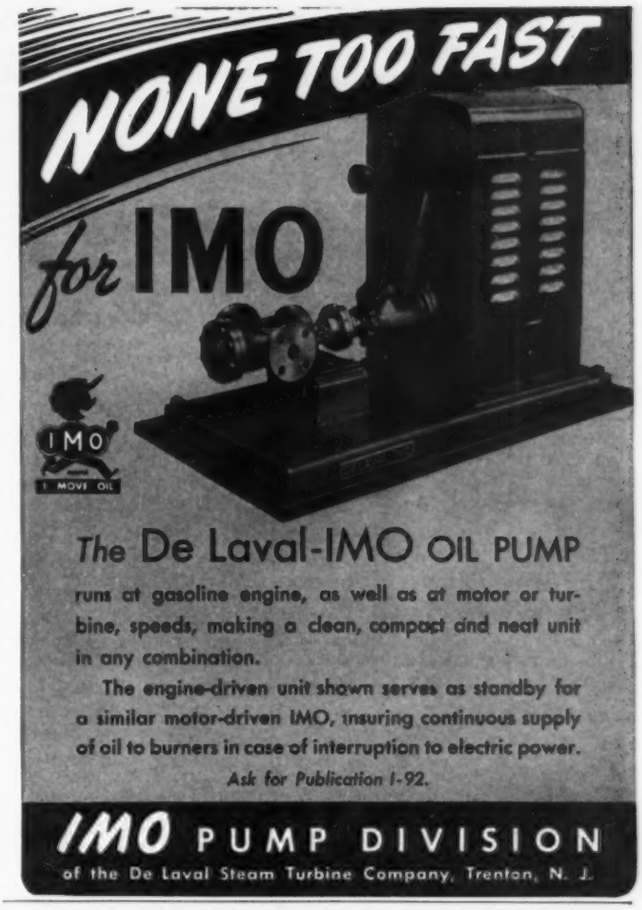
In a recent paper before the Institution of Mechanical Engineers, which is abridged in *Engineering* of March 6, R. B. Gillham discusses the burning of wood refuse for steam raising and gives results of an evaporative test on an installation with which he is associated.



Extended Dollken type furnace

At the plant described, three forms of wood refuse from three different shops were involved, namely, small blocks, shavings and sawdust, and fine dust from sanders. The first is delivered to the silo by a conveyor, the second by a pneumatic system with cyclones and the third, because of its explosive nature and relatively small quantity, is handled separately in sacks that are hand fed into the furnace. From the silo the refuse is conducted by a screw feeder and dropped into four-bladed box paddles above the furnaces.

The boilers, which are of the Lancashire type, have extended furnaces of the Dollken type built of brick, as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shown in the sketch. Only the heavier pieces of wood drop to the grate and combustion is reported as fairly complete with neither smoke nor sparks being emitted from the stack. Results of an evaporative test consisting of three separate runs of approximately 9 hr each, are as follows:

EVAPORATION TESTS

Hours	Water Evaporated, Lb	Fuel Consumed, Lb	Evaporation, Lb of Steam per Lb of Fuel
8.75	44,150	9,476	4.66
9.0	50,100	10,321	4.85
9.0	43,900	9,596	4.58
	138,150	29,393	4.7

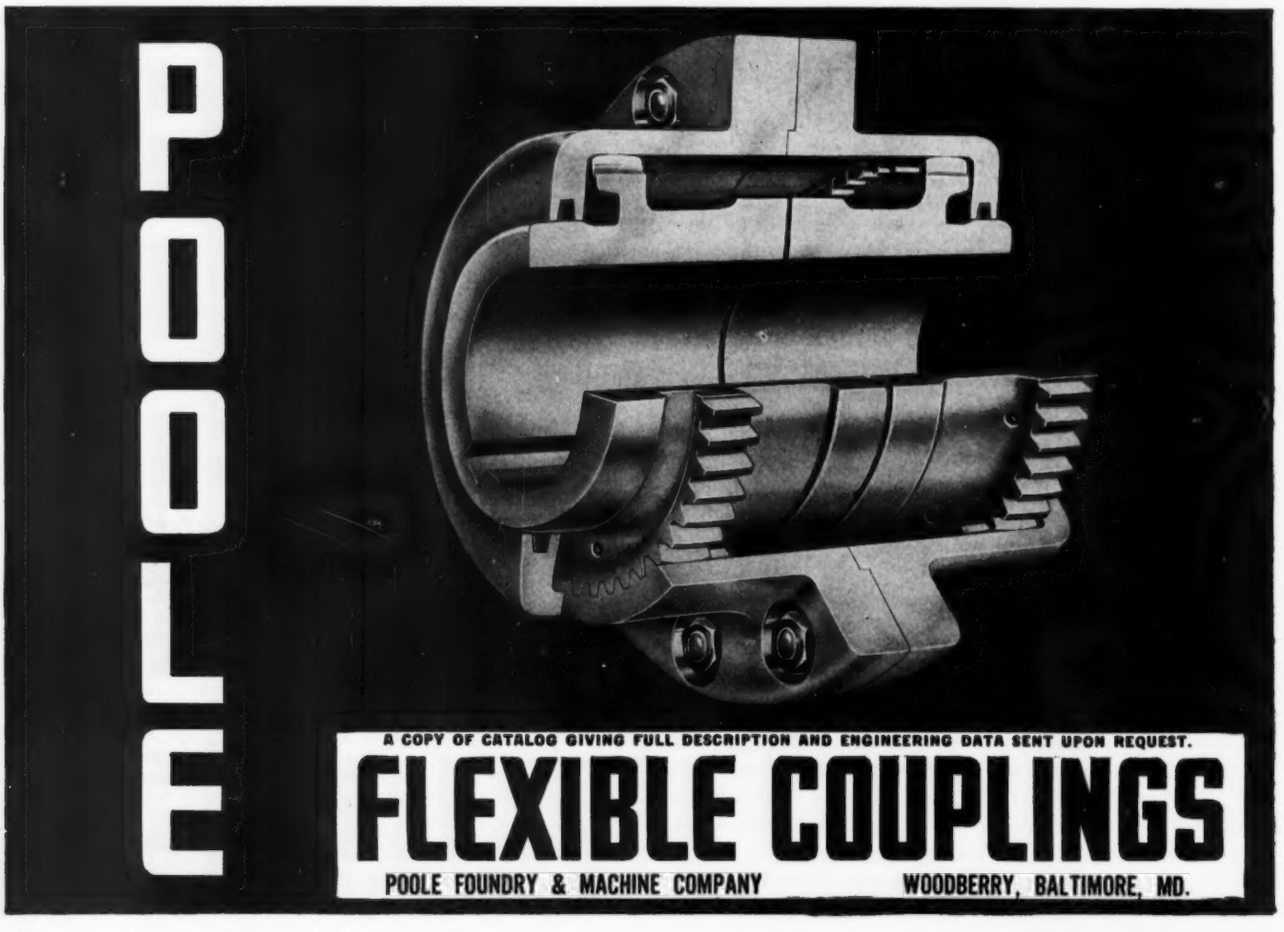
Evaporation per hour	5164.5 lb
Fuel consumed per hour	1098.8 lb
Steam pressure (saturated)	51 lb per sq in.
Total heat of steam	1184.2 Btu per lb
Feedwater temperature	140 F
Factor of evaporation	1.1071
Draught at boiler damper	0.75 in. wg
Evaporation per lb of fuel from and at 212 F	5.203 lb
Calorific value of wood refuse	7850 Btu per lb
Boiler efficiency	64.32 per cent

Turbine Blade Research Employs Wind Tunnel

In a paper read before the North East Coast Institution of Engineers and Shipbuilders and reported in *Engineering* (London) of February 13th, M. R. Youssef reports on wind-tunnel experiments conducted on model reaction turbine blades at the Royal Technical College, Glasgow. The experiments were made on blade models, several times the size of actual blades, so that the Reynolds number is maintained at a value of interest in turbine design, and with the idea of determining the optimum circumferential pitch for a given blade width. One of the main objectives was to examine the effects of the angular setting and circumferential spacing upon that component of the reaction which produces torque in the rotor. A table and curves are given presenting the results at five angles of incidence for each of the values of pitch selected.

Compact Steam Generator Employing High Heat Release

The Clarkson boiler of the coil type is not new, it having been on the market in England for the last twelve or fifteen years; but an unusually compact unit of this type is described in the January issue of *Industrial Power and Fuel Economist.* Occupying a space of approximately two by three feet it will produce up to 300 lb of steam per hr at 200 lb pressure and a temperature of 600 F. Firing is with oil with full automatic control, and a heat release of over a million Btu per cubic foot of combustion space is said to have been attained on test. The unit described is built for either stationary or portable use.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REVIEW OF NEW BOOKS

Any of the books here reviewed may be secured through Combustion Publishing Company, Inc., 200 Madison Ave., N. Y.

A Study of the Collapsing Pressure of Thin-Walled Cylinders

By Rolland George Sturm

This booklet (Bulletin 329), issued by the Engineering Experiment Station of the University of Illinois, presents an analysis of the elastic behavior of thin shells subjected to external pressure, and studies experimental results with that of theoretical analysis. Following a résumé of previous work and a chapter devoted to Theoretical Analysis subsequent chapters include: Solution of Buckling Equations for Round Cylinders Stiffened with Rings; Cylinders Slightly Out-of-Round; Extension to Plastic Action; Experimental Work; and, Summary and Conclusions. Photographic reproductions show examples of collapsed steel and aluminum-alloy tubes, and numerous curve charts indicate collapse coefficients, radial deflection and maximum stress. The booklet also contains a bibliography of forty important references.

This 80-page booklet, size 6 × 9, is nominally priced at 80 cents; however, a limited supply is available for free distribution, and may be obtained without charge upon application to the Engineering Experiment Station, Urbana, Illinois.

Directory of Electric Utilities in the United States—1941

Issued by the Federal Power Commission

This 1050-page book, which contains data on 4457 electric utilities serving 21,586 communities, was compiled by the Federal Power Commission in collaboration with the Work Projects Administration from data furnished by the utilities. It presents operating and statistical data concerning all publicly and privately owned electric utilities, and industrial plants which sell electric energy to the public. The following items are listed for each utility: Name of utility, its principal business address and the States in which it operates; the corporate control over the utility; names of officers and directors; companies controlled by the utility; electric utility plant in dollars; electric operating revenues; number of customers; generating capacity; kilowatt-hours generated and purchased; communities served at retail; utilities served at wholesale; and other services rendered. In addition, the new volume contains a detailed index of information available in the Commission's various statistical publications.

The publication is bound in blue simulated leather; the page size is approximately 6 × 9. The Directory will be sold at $2.00 a copy by the Federal Power Commission only, to which all orders should be addressed, enclosing cash, check or money order. In ordering, the publication may be referred to as "FPC S-19."

Power Plant Engineering and Design

By Frederick T. Morse

The second edition of Frederick T. Morse's "Power Plant Engineering and Design" holds to the original objective of presenting in one volume a complete study of electrical generating stations, including public service, industrial and institutional plants. The author has covered the mechanical and electrical aspects of power plant design and construction effectively and with due emphasis upon the economic factors involved. Approximately one-half of the text has been rewritten and many of the illustrations revised to include many refinements of design that have been introduced during the last ten years.

To those of us who are intimately concerned with steam generation, it may seem that the space devoted to boilers is regrettably small and out of balance with the rest of the book, and that the restriction imposes an incomplete picture of contemporary boiler types and present practice. Nevertheless, it is difficult to visualize a textbook which deals with the broader aspects of power generation more thoroughly.

The work comprises fifteen chapters; the first four include a General Introduction, The Variable Load Problem, Power Plant Economics, and The Power Plant Building. Chapters five to seven deal with Diesel Engine Power and the Hydro-Electric Plant. Chapters eight to twelve concern Vapor Cycles and Their Heat Balances, Steam Boilers, Prime Movers, and Condensers, The Gas Loop, The Feedwater Loop, and The Piping System. The last three chapters concern Electric System Equipment and Layout, and also Metering Equipment. The book is copiously illustrated and comprises 703 pages including a 15-page index. Bound in dark maroon buckram; size 6¼ × 9¼. Price $6.50

Proposed Revision of A.S.M.E. Code for Unfired Pressure Vessels

The Special Committee of the Boiler Code Committee to revise Section VIII of the A.S.M.E. Boiler Construction Code has recently completed a preliminary draft of the proposed revision, and this is now available for general distribution and critical review. Comments are invited from all interested parties and should be received by the Secretary of the Boiler Code Committee not later than July 1, 1942. Copies of this draft may be obtained from the American Society of Mechanical Engineers at $1.00 per copy.

Steam Boiler Yearbook and Manual—1942

Edited by Sydney D. Scorer

This is an English publication which has been produced under extremely difficult war conditions, and both editor and publisher are to be congratulated on their achievement. Its chief merit lies in the presentation of the latest available information on many technical problems which vitally concern the steam and combustion engineer, and it is flattering to note that much of this material has been gleaned from recent A.S.M.E. papers, and from articles which have appeared in this magazine.

Part I comprises a 260-page section dealing with various types of boilers and steam generating practice in England today; it contains 19 chapters, and while broad in scope it may be regarded as a foundation of a more comprehensive treatment at some future date. Part II comprises a collection of technical papers which have been condensed for this volume and grouped under the following headings: Coal Selection and Storage; Fuel Economy and Combustion; Pulverized Fuel; Oil Fuel; Ash; Design and Operation; Steam Generation; and Automatic Control. The work is admirably illustrated with 271 charts and drawings which are remarkably clear despite the poor quality of paper the publisher has been compelled to use. The use of small type is also dictated by war conditions but does not detract from the value of this notable work. The book contains 400 pages, size 5½ × 8½. Price 20*s*. plus postage ($4.50 approximately; two to three months delivery).

Symposium on Problems and Practice in Determining Steam Purity by Conductivity Methods

The technical papers and discussions comprising this symposium were recently published by the American Society for Testing Materials. Following an introduction by R. E. Hall is a detailed discussion on Sampling of Steam and Boiler Water by Messrs. Belyea and Moody, a description on Experimental Methods of Determining Conductivity Correction for Dissolved Gases in Steam Condensate by Messrs. Whirl and Lower, and a contribution by D. S. McKinney covering Calculation of Corrections to Conductivity Measurements for Dissolved Gases. A summary by P. B. Place of the methods and apparatus available for the elimination from steam samples of gaseous impurities that affect conductivity measurements is included and a new kind of conductivity apparatus for use with boiler waters and steam samples is described by A. R. Mumford. There is a general discussion on Conductivity Cells and Electrical Measuring Instruments. A combined bibliography on steam purity includes some 75 important references. Price—60 cents.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

Absolute Pressure Gage

The Brown Instrument Company has added an absolute pressure gage to its line of indicating, recording and control instruments. Bulletin 70-11 completely describes this new instrument which is designed to meet the needs of those process industries requiring an accurate measure and control of pressures below standard atmospheric pressure. The gage is available as a single record recorder or single record air operated controller, and models are available with ranges of 100, 200, 300, 400 and 500 mm of mercury absolute and 15 lb per sq in. absolute.

Automatic Controls for Marine Service

The Mason-Neilan Regulator Company has issued a 32-page two-color bulletin (M-100) describing its line of pressure regulators, and controlling, indicating and recording instruments. The equipment described covers six general applications—pressure regulation, tank-level control, tank-level indication, temperature control, boiler level and feed pump control and combustion control. The illustrations and cut-away sectional views are admirable, and the text is well supported by numerous diagrams of different control systems.

Gas and Oil Burners

A 4-page folder (No. 203), just received from the Peabody Engineering Corporation, describes the improved Type A and Type H gas and oil burners. Illustrations include photographic views of burner units, steam and mechanical atomizers and an installation view of this type of equipment.

Measurement and Control Instruments

The Bailey Meter Company has prepared a 20-page bulletin (No. 16) entitled "How to Safely Stretch Steaming Capacity" which is a check list of procedure for boiler room improvement. The bulletin explains how the proper use of metering and control equipment stretches steaming capacity, avoids shutdowns for maintenance, insures safety of men and equipment, furnishes data for comparison of fuels, and maintains efficiency while new operating crews are being trained. Illustrations include instrument panels, typical steam and air flow charts (in color), and a diagrammatic sketch showing the application of Bailey meters and control for a power-process steam plant.

Oil Burning System

A 4-page folder just received from the Peabody Engineering Corporation describes its constant differential system of control for wide range mechanical atomizers. Illustrations include sectional views of the atomizer tip and diagrams of both valve and pump systems.

Oil Circuit Breakers

A new 12-page catalog (3130), just released by the Roller-Smith Company, describes small oil circuit breakers for use on a-c circuits in industrial and power plants where interrupting capacities of 50,000 kva are required. Continuous carrying capacities range from 600 to 3000 amperes at voltages up to 15,000 volts. Manually and electrically operated designs are illustrated and typical control diagrams are given together with dimension drawings and a tabulation of the characteristics of each size of breaker.

Pressure Instruments

A new 24-page illustrated catalog (No. 76JF) has been issued by the Taylor Instrument Companies which describes the bourbon spring, bellows and manometer type instruments for indicating, recording and controlling pressures. Indicating mercury gages for absolute pressures and vacuums are also listed and complete information given on Taylor charts for pressure recorders and controllers.

Pulverizing and Separating Equipment

An 8-page bulletin, just received from the Raymond Pulverizer Division of Combustion Engineering Company, contains a brief description of Raymond mills, pulverizers and air separators for the production of powdered materials by dustless operation. This bulletin (No. 52) is attractively illustrated and shows the application of the whizzer separator and a flash-drying system with different types of grinding and separating equipment. Many types of mills are presented including Laboratory and Screen Mills, Imp and Automatic Pulverizers, Roller and Bowl Mills.

Smoke Density Recorders

The Leeds & Northrup Company has issued a 16-page catalog (N-93-163) describing equipment for indicating and recording smoke density. Many illustrations include installation views and full-size sections of rotating and strip charts. Mounting dimensions are given and a schematic diagram shows how a continuously flowing sample of smoke is drawn from the stack, measured and recorded.

Water-Testing Equipment

The Bird-Archer Company has issued a new 20-page booklet, fully illustrated, containing complete information on water-testing equipment, conductivity apparatus, proportioning pumps and chemical feeders. Methods of making control tests are also given.

SUBSTANTIAL INCREASE in Boiler Capacity—QUICK!

When existing boilers are rebaffled with Beco-Turner Baffles the increases in capacity are often substantial. The scientific design gets the most out of water tube boilers by increasing the area directly exposed to the hot gases. The construction is air tight in the beginning and remains that way during a long life because of the exclusive expansion feature which takes up the movement of heating and cooling.

If you are trying to "beat the schedule" and need more power, quickly, we suggest you send blueprints for our recommendation for efficient baffling of existing and new boilers. Ask for catalog showing typical applications.

PLIBRICO JOINTLESS FIREBRICK CO.
1820 Kingsbury Street Chicago, Illinois

Gas-Tight

BECO-TURNER BAFFLES

Efficient Design

Rules Issued for Handling Power Shortages

With the object of assuring a steady flow of power to war industries and essential uses, the War Production Board has set up machinery for handling power shortages wherever and whenever they occur. These regulations are set forth in order L-94 issued as of May 1.

Two lines of action against power shortages are covered. The first, which became effective at once, requires utilities to operate their systems in a way that will produce the maximum amount of power from their present capacity. This calls for integrating and tying together the systems to permit transfer of power from one locality to another where most needed, and to operate facilities so as to make available the maximum amount of power at peak periods, using water power as much as possible to save fuel. No utility is permitted to abandon any of its generating facilities except upon authorization from the WPB; and each is required to ascertain the amount and availability of private industrial power generating facilities of 100 kw or more in the territory served and make arrangements, where feasible, for connection with the utility's system. Where such voluntary arrangements fail, the fact must be reported to the Director of Industry Operations, together with all pertinent information; and if deemed necessary, the latter may then issue specific directions for such integration of power facilities.

The second part of the order, which will be put into operation when and where power shortages occur, sets up rules for mandatory curtailment of power for commercial and industrial consumers, with further provisions for the curtailment of residential consumers. When a power shortage develops, the Director of Industry Operations will define the area affected and issue specific instructions to utilities, non-utility power producers and consumers to relieve the shortage. He will establish emergency curtailment schedules and put into operation any or all of the following power-saving measures:

1. Eliminate all non-essential lighting, such as sign lighting, show window lighting, flood lighting of athletic fields, and restrict lighting in stores and other public establishments to one watt per square foot of floor space. This would permit not more than fifty 100-watt bulbs in a store with a floor space of 50 × 100 feet.
2. Restrict or prohibit the use of electric power during peak periods. Such action would affect all consumers.
3. Limit delivery of power to an industrial customer to a power usage which will be based on a percentage of his highest demand during the 12 months from May 1, 1941 to April 30, 1942.
4. Restrict the consumption of large non-residential consumers using more than 2500 kw hr a week to a weekly quota based on a percentage of their power consumption in April 1942 or any other period fixed by the WPB.
5. Restrict the consumption of consumers (residential and small commercial) using 2500 or less kilowatt-hours on a basis to be fixed at the time of the shortage.

Consumers exempt from the curtailment include: governmental and community services, such as street lights and power for hospitals and schools; transportation services; communications services; military establishments; and plants engaged exclusively in war production.

Paper Mill Superintendents Association Annual Convention

The Twenty-Third Annual Convention of the American Pulp and Paper Mill Superintendents Association will be held this year at the Pantlind Hotel, Grand Rapids, Michigan, from Monday to Thursday, June 15 to 18, inclusive. Considerable discussion is expected among the Plant and Power Engineers Group on the subject, "Maintenance, etc.," which is the topic scheduled for 10 a.m. and 2 p.m. on Tuesday, June 16. Mr. Grover Keeth is Chairman of this group and Mr. George W. Craigie is Convention Manager.

PRESSED FOR TIME ON FURNACE REPAIRS?

Meet It with Service Tested R&I #3000 REFRACTORY CEMENT

FOR YOUR JOB

R&I #3000 is a plastic, ready mixed bonding refractory cement, packed in 100, 500 and 800 lb. containers. It has a melting point of 3000 deg. F. and the same expansion and contraction as #1 fire brick.

YOU BEAT THE BREAKDOWN

With R & I #3000 you quickly make strong, thin joints in laying new brickwork; repair linings and settings in walls, arches, floors, baffles, doors and can be used for wash coating. The joint air sets to full strength and withstands severe firing conditions. R&I #3000 can also be mixed with crushed firebrick to make quick large patches. This cement can be used for either hot or cold patching.

THE JOB LASTS LONGER

No refractory brick you use is stronger or more durable than the bond you make with R&I #3000 Refractory Cement. It increases refractory life and cuts down materially on furnace outage hours and service repairs.

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120 WALL ST., NEW YORK, N. Y.

Send Bulletin and Prices on #3000

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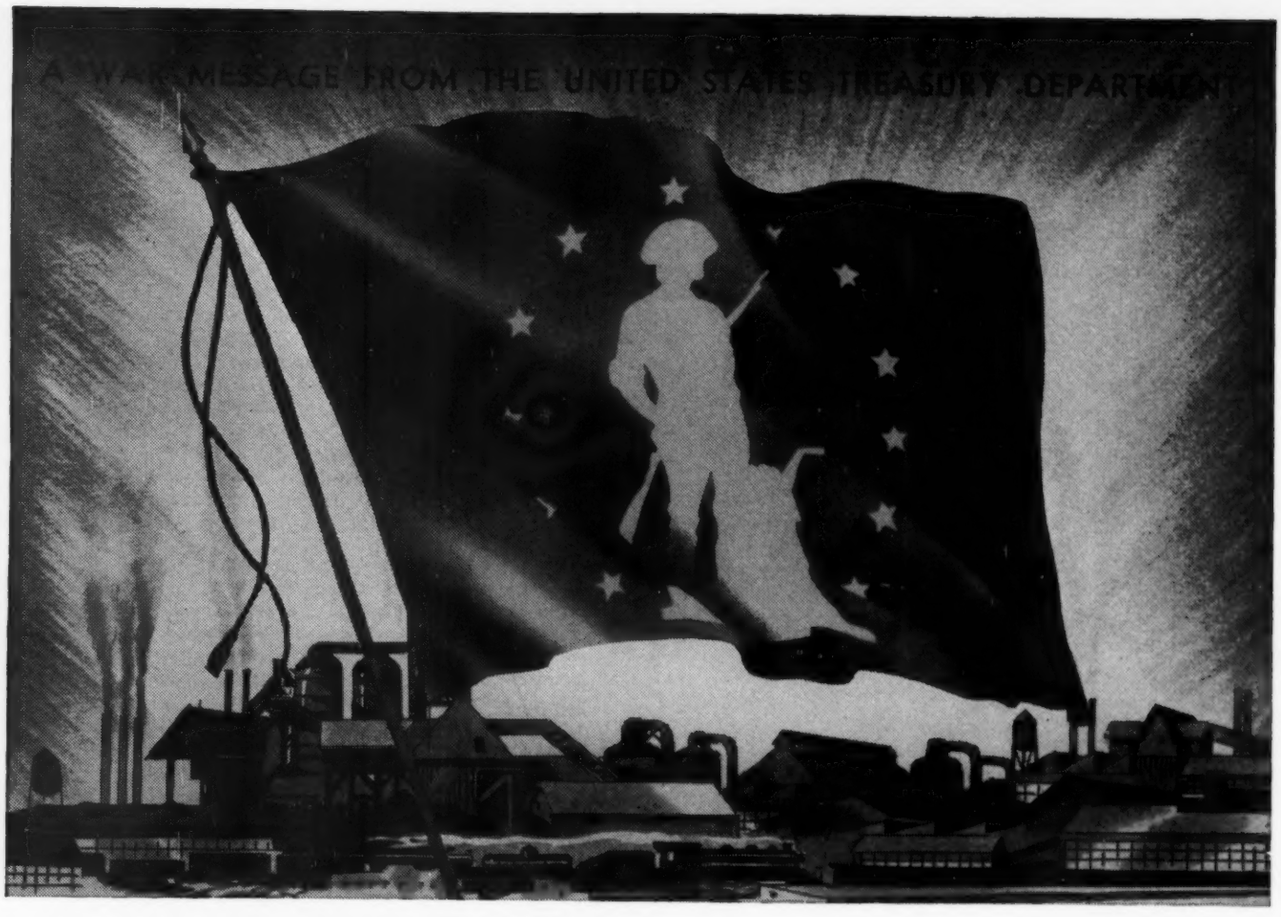
Learn about the cement that saves you time and trouble by using the coupon.



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Signifying 90 Percent or More Employee Participation in the Pay-Roll Savings Plan

IT doesn't go into the smoke of battle, but wherever you see this flag you know that it spells Victory for our boys on the fighting fronts. To everyone, it means that the firm which flies it has attained 90 percent or more employee participation in the Pay-Roll Savings Plan . . . that their employees are turning a part of their earnings into tanks and planes and guns *regularly,* every pay day, through the systematic purchase of U. S. War Bonds.

You don't need to be engaged in war production activity to fly this flag. Any patriotic firm can qualify and make a vital contribution to Victory by making the Pay-Roll Savings Plan available to its employees, and by securing 90 percent or more employee participation. Then notify your State Defense Savings Staff Administrator that you have reached the goal. He will tell you how you may obtain your flag.

If your firm has already installed the Pay-Roll Savings Plan, now is the time to increase your efforts: (1) To secure wider participation and reach the 90-percent goal; (2) to encourage employees to increase their allotments until 10 percent or more of your gross pay roll is subscribed for Bonds. "Token" allotments will not win this war any more than "token" resistance will keep our enemies from our shores, our homes. If your firm has yet to install the Plan, remember, TIME IS SHORT.

Write or wire for full facts and literature on installing your Pay-Roll Savings Plan now. Address Treasury Department, Section D, 709 12th St., NW., Washington, D. C.

Make Every Pay Day "Bond Day"

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This Space is a Contribution to Victory by **COMBUSTION**

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A.S.M.E. at Cleveland

The Semi-Annual Meeting of the American Society of Mechanical Engineers is scheduled for June 8 to 10 at the Statler Hotel, Cleveland, O. Simultaneous sessions will be held each day and the general theme of the program has been attuned to war problems. For example, the second Power Session, on Wednesday afternoon, June 10, will be devoted entirely to a round-table discussion of "Problems Confronting the Public Utilities in Producing Power for Offensive War" and wide participation is invited. There will be another round-table conference on the "Conservation, Reclamation and Substitution in Aircraft and Aircraft Parts Manufacture" at the Second Aviation Session on Monday evening. The Management Division will hold a similar discussion dealing with "Material Substitution and Salvage" on Wednesday morning; and ordnance inspection will be the general topic of three papers at the Production Engineering Division Session on Tuesday morning. Synthetic rubber and special rubber compounds will be the subject of two papers on Monday afternoon.

Aside from the papers having direct bearing on war production, there will be others of particular interest to power men; these include the following:

Tuesday, 9:30 a.m.

"Spreader Stokers Applied to Marine Boilers," by Otto de Lorenzi of Combustion Engineering Company.

"Modern Applications of Over-fire Air," by H. C. Carroll of Commercial Testing & Engineering Company.

Tuesday, 2:00 p.m.

"Corrosion of Stressed Alloy Steel Bars by High-Temperature Steam," by H. L. Solberg, A. A. Potter, G. A. Hawkins and J. T. Agnew, of Purdue University.

"An Improved Technique for the Rolling-in of Small Tubes Used in Heat Exchangers, Except Boilers," by F. F. Fisher and E. T. Cope of the Detroit Edison Company.

"Heat Transfer and Pressure Drop in Ljungstrom Type Air Preheaters," by Hilmer Karlsson and Sven Holm of the Air Preheater Corporation.

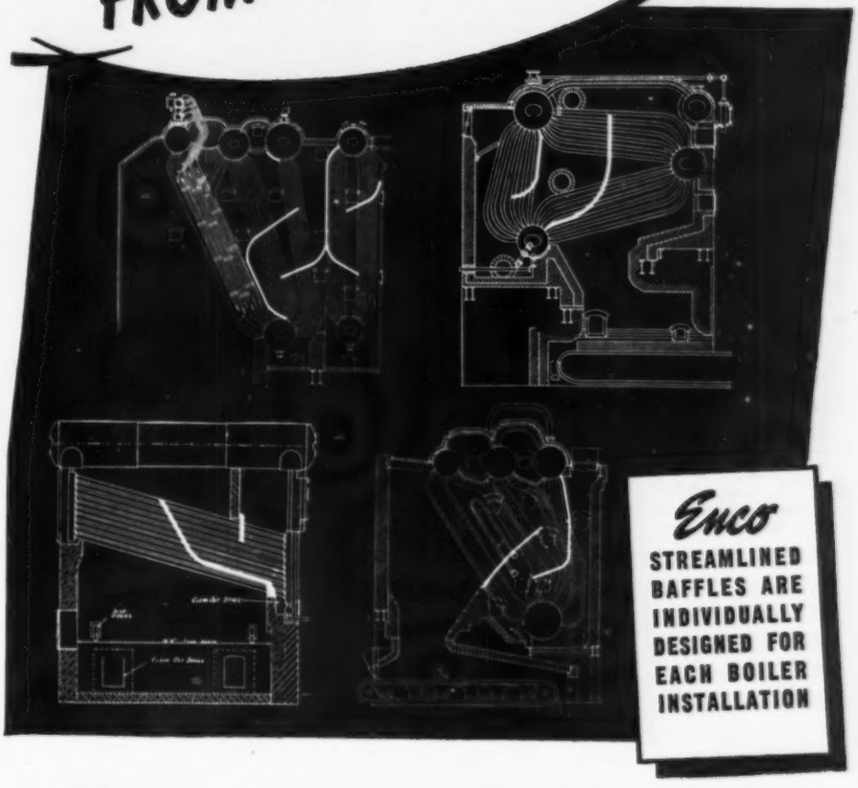
The Fuels Session on Monday afternoon will deal with industrial applications of pulverized coal and radiant tube furnaces, and that on Monday evening will be devoted to domestic fuel problems.

"Education and Training for Industry Before and After War" will be discussed on Tuesday morning in papers by James D. Cunningham of Republic Flow Meters Company, by C. A. McKeeman of the Case School of Applied Science, and by Dean C. E. MacQuigg of Ohio State University.

N.D.H.A. to Meet at Dayton

The Thirty-Third Annual Meeting of the National District Heating Association will be held at Dayton, Ohio, on June 11 and 12. Headquarters will be at the Biltmore Hotel. As customary, the program instead of including papers on specific topics, will be devoted largely to the presentation and discussion of committee reports, including those on steam station engineering, operating statistics, distribution, chemistry and research.

THE Quickest WAY TO GET MORE STEAM FROM YOUR BOILERS



Enco STREAMLINED BAFFLES ARE INDIVIDUALLY DESIGNED FOR EACH BOILER INSTALLATION

RIGHT now, when most power plants are taxed to the limit, the type and construction of the baffle walls in your boilers are of the utmost importance.

That much needed extra capacity, plus lowered operating and maintenance costs can be obtained by the installation of ENCO Streamlined BAFFLE WALLS. We've spent 25 years perfecting baffle wall design and materials to a point where they greatly influence boiler performance.

Write for Bulletin BW-40 or, for quick action, send blue prints and operating data. There is no obligation.

THE ENGINEER COMPANY
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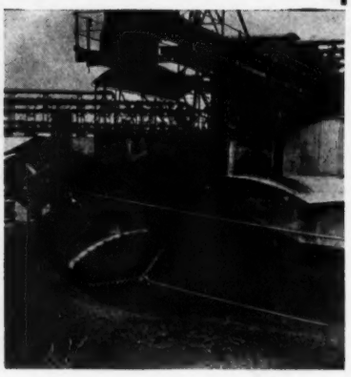
Enco Streamline Baffles
PRODUCED EXCLUSIVELY BY THE ENGINEER COMPANY

Store and Reclaim Coal for few cents per ton.....



SAUERMAN Scrapers are on record as handling coal for under 2c per ton at large power plants and for only slightly more at small plants.

This operating economy is just one of many reasons why SAUERMAN Scrapers have become the most widely used equipment for open storage of coal. Other advantages are:

- Machine is simple and easy to operate. From a station overlooking the storage area the operator controls every move of the scraper through a set of automatic controls.
- The equipment is adaptable to any ground regardless of the shape or condition of the area.
- Scraper piles coal in compact layers. There is no segregation of lumps and fines; no air pockets to promote spontaneous combustion.
- Each SAUERMAN installation is a permanent, trouble-free investment. Upkeep is easy.

Picture shows SAUERMAN Scraper moving coal out onto storage pile. Scrapers are made in sizes to carry ¼-ton to 10-ton loads of coal.

If you have any coal storage problem write for the SAUERMAN Catalog.

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550 S. Clinton Street, Chicago

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POWER SCRAPERS **FOR STOCKPILING**

A. J. Moses Elected C. E. C. Vice-President

The election of A. J. Moses as a vice-president of Combustion Engineering Company, Inc., was announced by J. V. Santry, president of the company, following recent action by the Board of Directors.

Mr. Moses, a graduate of Georgia School of Technology, has been connected with Combustion Engineering Company, or its constituent companies, since 1920 and for several years past has been General Manager of the company's Hedges-Walsh-Weidner Division at Chattanooga. He will continue to be responsible for operations of this major manufacturing division which is now engaged almost entirely in production related to the war effort.

An authority on welding and X-raying, Mr. Moses is the author of numerous articles and society papers on welding and the fabrication of welded pressure vessels. His technical society memberships include the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Welding Society and the Chattanooga Engineers Club, several of which he has served on important committees.

New Architect-Engineer Organization Formed

With the object of providing in one comprehensive group, architectural and engineering services for consultation, design, contract award and unified control of large construction projects which is so desirable at the present time, the firm of Binger-O'Connor-Orrok has been formed with offices at 101 Park Avenue, New York City. The partners are Walter D. Binger, civil engineer; Robert B. O'Connor, architect; Geo. A. Orrok, civil, mechanical and power engineer; Harvey Stevenson, architect; and David Moffat Myers, mechanical and power engineer. Benjamin W. Morris will assist as a consulting architect. Each of the foregoing has individually long been engaged in consulting, design and construction work in their respective fields, and the new firm has already completed its first job for the U. S. Army and been commissioned with a second.

Messrs. Orrok and Myers will also continue their consulting practice at their old office, 21 East 40th Street, New York.

Used Power Equipment Frozen

According to an announcement issued by the Office of Emergency Management on April 20, the sale of all used electric generating equipment and used steam boilers, including those reconditioned, and which exceed $1000 in market value, has been frozen in order to promote most effective use in the war effort.

Also, because of the war requirements for heavy compressors for the synthetic rubber, toluene, aviation gas, oxygen and ammonia programs, such equipment has been placed under a system of complete allocation. This means that, regardless of any prior commitment or preference rating, manufacturers may deliver heavy compressors only in accordance with a set procedure established by the Director of Industry Operations. As defined by the order, heavy compressors mean any crank-and-flywheel type horizontal reciprocating compressors or dry vacuum pumps having a displacement of 50 cu ft per min or more, or any other reciprocating compressors having a displacement of 300 cu ft per min or more. This applies to new, second-hand or reconditioned equipment.

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